UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1998

HIGH SCHOOL APPRENTICESHIP PROGRAM FINAL REPORTS

VOLUME 13

ROME LABORATORY

RESEARCH & DEVELOPMENT LABORATORIES

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PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

This document is one of a set of 15 volumes describing the 1998 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2	Armstrong Laboratory
3	Phillips Laboratory
4	Rome Laboratory
5A & 5B	Wright Laboratory
6	Arnold Engineering Development Center, Air Logistics Centers, United States Air Force Academy and Wilford Hall Medical Center
	Graduate Student Research Program (GSRP) Reports
7	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10	Wright Laboratory
11	Arnold Engineering Development Center, and Wilford Hall Medical Center
	High School Apprenticeship Program (HSAP) Reports
12	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
15A, 15B & 15C	Wright Laboratory

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13. ABSTRACT *(Maximum 200 words)*

The United States Air Force Summer Research Program (USAF-SRP) is designed to introduce university, college, and technical institute faculty members, graduate students, and high school students to Air Force research. This is accomplished by the faculty members (Summer Faculty Research Program, (SFRP)), graduate students (Graduate Student Research Program (GSRP)), and high school students (High School Apprenticeship Program (HSAP)) being selected on a nationally advertised competitive basis during the summer intersession period to perform research at Air Force Research Laboratory (AFRL) Technical Directorates, Air Force Air Logistics Centers (ALC), and other AF Laboratories. This volume consists of a program overview, program management statistics, and the final technical reports from the HSAP participants at the Rome Laboratory.

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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The numbers of projected summer research participants in each of the three categories and SREP "grants" are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest, and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1997 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL (in 1993) won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

YEAR	SRP Participation, by Year			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442
1995	190	115	137	442
1996	188	109	138	435
1997	148	98	140	427
1998	85	40	88	213

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years. Since then, the number of funded positions has remained fairly constant at a slightly lower level.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 52-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous individual requesters (over 1000 annually).

RDL placed advertisements in the following publications: *Black Issues in Higher Education, Winds of Change,* and *IEEE Spectrum.* Because no participants list either *Physics Today* or *Chemical & Engineering News* as being their source of learning about the program for the past several years, advertisements in these magazines were dropped, and the funds were used to cover increases in brochure printing costs.

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1998 are shown in this table.

1998 Applicants and Participants			
PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP	382	85	13
(HBCU/MI)	(0)	(0)	(0)
GSRP	130	40	7
(HBCU/MI)	(0)	(0)	(0)
HSAP	328	88	22
TOTAL	840	213	42

4. SITE VISITS

During June and July of 1998, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

Before 1993, an RDL program representative visited from seven to ten different HBCU/MIs annually to promote interest in the SRP among the faculty and graduate students. These efforts were marginally effective, yielding a doubling of HBCI/MI applicants. In an effort to achieve AFOSR's goal of 10% of all applicants and selectees being HBCU/MI qualified, the RDL team decided to try other avenues of approach to increase the number of qualified applicants. Through the combined efforts of the AFOSR Program Office at Bolling AFB and RDL, two very active minority groups were found, HACU (Hispanic American Colleges and Universities) and AISES (American Indian Science and Engineering Society). RDL is in communication with representatives of each of these organizations on a monthly basis to keep up with the their activities and special events. Both organizations have widely-distributed magazines/quarterlies in which RDL placed ads.

Since 1994 the number of both SFRP and GSRP HBCU/MI applicants and participants has increased ten-fold, from about two dozen SFRP applicants and a half dozen selectees to over 100 applicants and two dozen selectees, and a half-dozen GSRP applicants and two or three selectees to 18 applicants and 7 or 8 selectees. Since 1993, the SFRP had a two-fold applicant increase and a two-fold selectee increase. Since 1993, the GSRP had a three-fold applicant increase and a three to four-fold increase in selectees.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates.

SRP HBCU/MI Participation, By Year				
YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6
1995	90	21	20	8
1996	119	27	18	7

6. SRP FUNDING SOURCES

Funding sources for the 1998 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1998 SRP selected participants are shown here.

1998 SRP FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	67	38	75
USAF Laboratory Funds	17	2	13
Slots Added by AFOSR (Leftover Funds)	0	0	0
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	0	0	N/A
TOTAL	84	40	88

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

1998 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994	1995	1996	1997	1998
Faculty Members	$690	$718	$740	$740	$740	$770	$770	$793
Graduate Student (Master's Degree)	$425	$442	$455	$455	$455	$470	$470	$484
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391	$391	$400	$400	$412
High School Student (First Year)	$200	$200	$200	$200	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $52/day for faculty and $41/day for graduate students. Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 65 % claimed travel reimbursements at an average round-trip cost of $730.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-three percent (85 out of 188) of faculty associates took orientation trips at an average cost of $449. By contrast, in 1993, 58 % of SFRP associates elected to take an orientation visits at an average cost of $685; that was the highest percentage of

associates opting to take an orientation trip since RDL has administered the SRP, and the highest average cost of an orientation trip.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

This is the third year of using direct deposit for the SFRP and GSRP associates. The process went much more smoothly with respect to obtaining required information from the associates, about 15% of the associates' information needed clarification in order for direct deposit to properly function as opposed to 7% from last year. The remaining associates received their stipend and expense payments via checks sent in the US mail.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1998 REPORT

The complete set of reports for the 1998 SRP includes this program management report (Volume 1) augmented by fifteen volumes of final research reports by the 1998 associates, as indicated below:

1998 SRP Final Report Volume Assignments

LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, ALCs, USAFA, WHMC	6	11	

APPENDIX A – PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP associates represented 169 different colleges, universities, and institutions, GSRP associates represented 95 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 47 states plus Washington D.C. Selectees represent 44 states.

GSRP - Applicants came from 44 states. Selectees represent 32 states.

HSAP - Applicants came from thirteen states. Selectees represent nine states.

Total Number of Participants	
SFRP	85
GSRP	40
HSAP	88
TOTAL	213

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	83	0	83
Master's	1	3	4
Bachelor's	0	22	22
TOTAL	186	25	109

SFRP Academic Titles	
Assistant Professor	36
Associate Professor	34
Professor	15
Instructor	0
Chairman	0
Visiting Professor	0
Visiting Assoc. Prof.	0
Research Associate	0
TOTAL	85

Source of Learning About the SRP		
Category	Applicants	Selectees
Applied/participated in prior years	177	47
Colleague familiar with SRP	104	24
Brochure mailed to institution	101	21
Contact with Air Force laboratory	101	39
IEEE Spectrum	12	1
BIIHE	4	0
Other source	117	30
TOTAL	616	162

APPENDIX B – SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	100
HSAPs	75
USAF Laboratory Focal Points	84
USAF Laboratory HSAP Mentors	6

All groups indicate unanimous enthusiasm for the SRP experience.

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below:

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Faculty Associates suggest higher stipends for SFRP associates.

C. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same argument was used to raise the faculty and graduate student participation time a few years ago.)

2. 1998 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 84 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ? (% Response)											
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	0	-	-	-	-	-	-	-	-	-	-	-	-
WHMC	0	-	-	-	-	-	-	-	-	-	-	-	-
AL	7	28	28	28	14	54	14	28	0	86	0	14	0
USAFA	1	0	100	0	0	100	0	0	0	0	100	0	0
PL	25	40	40	16	4	88	12	0	0	84	12	4	0
RL	5	60	40	0	0	80	10	0	0	100	0	0	0
WL	46	30	43	20	6	78	17	4	0	93	4	2	0
Total	**84**	**32%**	**50%**	**13%**	**5%**	**80%**	**11%**	**6%**	**0%**	**73%**	**23%**	**4%**	**0%**

LFP Evaluation Summary. The summarized responses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5. a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
    b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Table B-3. Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*USAFA*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	0	7	1	14	5	0	46
Question #							
2	-	86 %	0 %	88 %	80 %	-	85 %
2a	-	4.3	n/a	3.8	4.0	-	3.6
2b	-	4.0	n/a	3.9	4.5	-	4.1
3	-	4.5	n/a	4.3	4.3	-	3.7
4	-	4.1	4.0	4.1	4.2	-	3.9
5a	-	4.3	5.0	4.3	4.6	-	4.4
5b	-	4.5	n/a	4.2	4.6	-	4.3
6a	-	4.5	5.0	4.0	4.4	-	4.3
6b	-	4.3	n/a	4.1	5.0	-	4.4
6c	-	3.7	5.0	3.5	5.0	-	4.3
7a	-	4.7	5.0	4.0	4.4	-	4.3
7b	-	4.3	n/a	4.2	5.0	-	4.4
7c	-	4.0	5.0	3.9	5.0	-	4.3
8	-	4.6	4.0	4.5	4.6	-	4.3
9	-	4.9	5.0	4.4	4.8	-	4.2
10a	-	5.0	n/a	4.6	4.6	-	4.6
10b	-	4.7	5.0	3.9	5.0	-	4.4
11	-	4.6	5.0	4.4	4.8	-	4.4
12	-	4.0	4.0	4.0	4.2	-	3.8
13a	-	3.2	4.0	3.5	3.8	-	3.4
13b	-	3.4	4.0	3.6	4.5	-	3.6
14	-	4.4	5.0	4.4	4.8	-	4.4

3. 1998 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 120 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from 1 (below average) to 5 (above average) - by Air Force base results and over-all results of the 1998 evaluations are listed after the questions.

1. The match between the laboratories research and your field:
2. Your working relationship with your LFP:
3. Enhancement of your academic qualifications:
4. Enhancement of your research qualifications:
5. Lab readiness for you: LFP, task, plan:
6. Lab readiness for you: equipment, supplies, facilities:
7. Lab resources:
8. Lab research and administrative support:
9. Adequacy of brochure and associate handbook:
10. RDL communications with you:
11. Overall payment procedures:
12. Overall assessment of the SRP:
13. a. Would you apply again?
    b. Will you continue this or related research?
14. Was length of your tour satisfactory?
15. Percentage of associates who experienced difficulties in finding housing:
16. Where did you stay during your SRP tour?
    a. At Home:
    b. With Friend:
    c. On Local Economy:
    d. Base Quarters:
17. Value of orientation visit:
    a. Essential:
    b. Convenient:
    c. Not Worth Cost:
    d. Not Used:

SFRP and GSRP associate's responses are listed in tabular format on the following page.

Table B-4. 1997 SFRP & GSRP Associate Responses to SRP Evaluation

	Arnold	Brooks	Edwards	Eglin	Griffis	Hanscom	Kelly	Kirtland	Lackland	Robins	Tyndall	WPAFB	average
# res	6	48	6	14	31	19	3	32	1	2	10	85	257
1	4.8	4.4	4.6	4.7	4.4	4.9	4.6	4.6	5.0	5.0	4.0	4.7	4.6
2	5.0	4.6	4.1	4.9	4.7	4.7	5.0	4.7	5.0	5.0	4.6	4.8	4.7
3	4.5	4.4	4.0	4.6	4.3	4.2	4.3	4.4	5.0	5.0	4.5	4.3	4.4
4	4.3	4.5	3.8	4.6	4.4	4.4	4.3	4.6	5.0	4.0	4.4	4.5	4.5
5	4.5	4.3	3.3	4.8	4.4	4.5	4.3	4.2	5.0	5.0	3.9	4.4	4.4
6	4.3	4.3	3.7	4.7	4.4	4.5	4.0	3.8	5.0	5.0	3.8	4.2	4.2
7	4.5	4.4	4.2	4.8	4.5	4.3	4.3	4.1	5.0	5.0	4.3	4.3	4.4
8	4.5	4.6	3.0	4.9	4.4	4.3	4.3	4.5	5.0	5.0	4.7	4.5	4.5
9	4.7	4.5	4.7	4.5	4.3	4.5	4.7	4.3	5.0	5.0	4.1	4.5	4.5
10	4.2	4.4	4.7	4.4	4.1	4.1	4.0	4.2	5.0	4.5	3.6	4.4	4.3
11	3.8	4.1	4.5	4.0	3.9	4.1	4.0	4.0	3.0	4.0	3.7	4.0	4.0
12	5.7	4.7	4.3	4.9	4.5	4.9	4.7	4.6	5.0	4.5	4.6	4.5	4.6
Numbers below are percentages													
13a	83	90	83	93	87	75	100	81	100	100	100	86	87
13b	100	89	83	100	94	98	100	94	100	100	100	94	93
14	83	96	100	90	87	80	100	92	100	100	70	84	88
15	17	6	0	33	20	76	33	25	0	100	20	8	39
16a	-	26	17	9	38	23	33	4	-	-	-	30	
16b	100	33	-	40	-	8	-	-	-	-	36	2	
16c	-	41	83	40	62	69	67	96	100	100	64	68	
16d	-	-	-	-	-	-	-	-	-	-	-	0	
17a	-	33	100	17	50	14	67	39	-	50	40	31	35
17b	-	21	-	17	10	14	-	24	-	50	20	16	16
17c	-	-	-	-	10	7	-	-	-	-	-	2	3
17d	100	46	-	66	30	69	33	37	100	-	40	51	46

4. 1998 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

Not enough evaluations received (5 total) from Mentors to do useful summary.

5. 1998 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 23 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

1. Your influence on selection of topic/type of work.
2. Working relationship with mentor, other lab scientists.
3. Enhancement of your academic qualifications.
4. Technically challenging work.
5. Lab readiness for you: mentor, task, work plan, equipment.
6. Influence on your career.
7. Increased interest in math/science.
8. Lab research & administrative support.
9. Adequacy of RDL's Apprentice Handbook and administrative materials.
10. Responsiveness of RDL communications.
11. Overall payment procedures.
12. Overall assessment of SRP value to you.
13. Would you apply again next year? Yes (92 %)
14. Will you pursue future studies related to this research? Yes (68 %)
15. Was Tour length satisfactory? Yes (82 %)

	Arnold	Brooks	Edwards	Eglin	Griffiss	Hanscom	Kirtland	Tyndall	WPAFB	Totals
# resp	5	19	7	15	13	2	7	5	40	113
1	2.8	3.3	3.4	3.5	3.4	4.0	3.2	3.6	3.6	3.4
2	4.4	4.6	4.5	4.8	4.6	4.0	4.4	4.0	4.6	4.6
3	4.0	4.2	4.1	4.3	4.5	5.0	4.3	4.6	4.4	4.4
4	3.6	3.9	4.0	4.5	4.2	5.0	4.6	3.8	4.3	4.2
5	4.4	4.1	3.7	4.5	4.1	3.0	3.9	3.6	3.9	4.0
6	3.2	3.6	3.6	4.1	3.8	5.0	3.3	3.8	3.6	3.7
7	2.8	4.1	4.0	3.9	3.9	5.0	3.6	4.0	4.0	3.9
8	3.8	4.1	4.0	4.3	4.0	4.0	4.3	3.8	4.3	4.2
9	4.4	3.6	4.1	4.1	3.5	4.0	3.9	4.0	3.7	3.8
10	4.0	3.8	4.1	3.7	4.1	4.0	3.9	2.4	3.8	3.8
11	4.2	4.2	3.7	3.9	3.8	3.0	3.7	2.6	3.7	3.8
12	4.0	4.5	4.9	4.6	4.6	5.0	4.6	4.2	4.3	4.5
Numbers below are percentages										
13	60%	95%	100%	100%	85%	100%	100%	100%	90%	92%
14	20%	80%	71%	80%	54%	100%	71%	80%	65%	68%
15	100%	70%	71%	100%	100%	50%	86%	60%	80%	82%

COMPUTER ANIMATION OF GLOBAL SEARCH ALGORITHMS

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Rome Laboratory

August 1998

Computer Animation of Global Search Algorithms

Kari Berg (Student Researcher)

Holland Patent High School

Abstract

The assigned summer project was to create animations to demonstrate how the global search algorithm solves the air/sealift scheduling and the quasigroup completion problems (QCP). The air/sealift scheduling problem schedules cargo on planes and ships. Because of the complexity and branching factor of the air/sealift scheduling algorithm, creative ways of representing the steps in the algorithm had to be used. The air/sealift scheduling problem is very significant to the Defense Transportation System for military deployments and employments during the response to a crisis situation.

The quasigroup completion problem is a "N" by "N" Latin square filled with colors (see figures) so each color is not repeated in any row or column for a possible solution. Some of the squares are preassigned colors and the algorithm tries to complete the problem. The quasigroup completion problem was animated as a search tree for a 2 by 2 and 3 by 3 Latin Square. The quasigroup problem has been used to unlock some of the secrets of computation. Macromedia Director was used for the animation and Adobe PhotoShop was used for some of the graphics.

Computer Animation of Global Search Algorithms

Author: Kari Berg

Introduction

The air/sealift scheduling problem is to assign and schedule cargo onto planes and ships in a way that the cargo travels from its origin to its destination quickly and efficiently meeting given deadlines. The Kestrel Transportation Scheduler, from Kestrel Institute, was the basis of our animation. It is important to determine a fast and efficient way of assigning and scheduling resources to provide maximum air and sealift capability in a time of crisis. This allows the United States to rapidly deliver whatever is needed whenever, wherever and worldwide to help, support our national policy or to support friends and allies when needed. Whenever national interests are threatened, The National Command Authorities will use military forces and the military transportation system.

Work was started on the air/sealift animation problem until the it became increasingly onerous. The quasigroup problem was then proposed by Dr. Carla Gomes to get a better understanding of how the global search algorithm works. Afterwards I continued work on the air/sealift animation.

Discussion of Problem

The animation is a visualization of the KTS algorithm (computer process). The animation effort was targeted to better explain and gain wider acceptance of the Kestrel Transportation Scheduler (KTS) and the methodology used to create it [Smith and Parra, 1993]. Although the scheduler has been available

since 1993, it has not gained wide acceptance in the military transportation community. Air Mobility Command is using the KTS techniques for their next generation airlift Scheduler called CAMPS. The global search algorithm takes all the possible combinations and reduces them until only the feasible solutions are left. The global search algorithm can be used for any scheduling system. The Global Search Algorithm for air/sealift scheduling takes all possible combinations of cargo scheduled on planes and ships and performs a narrowing down assessment until it finds one combination (of cargo items and transportation modes) that allows all the cargo to be at its destinations on time. If no feasible solution can be found one version of the scheduler relaxes the due dates to find a solution. All the pieces of cargo have constraints as to where the cargo must start and end and earliest load, earliest arrival and latest arrival dates. The scheduler sorted the cargo by cargo slack time. KTS then schedules the cargo on the correct plane by taking several factors into consideration. The cargo had to be at its destination on time and there had to be enough room for the cargo on the plane. Since the possible combinations explored by KTS could not be animated in a reasonable manner concise representations were created.

The QCP Problem is filling in squares in a grid so no two of the same colors occur in the same row or column. The Global Search Algorithm was shown with two animations for backtracking and propagation (see figure). The animation shows the algorithm search tree for the quasigroup completion problem. The commercial product "Macromedia Director" was used to produce the animations.

Methodology

Animation was used to make the KTS algorithm more easily comprehensible. Macromedia Director 6 Multimedia Studio was used in the animation of this problem because there were several technical and operational constraints and factors that had to be shown. Such as each plane had a maximum capacity and weight limit that could not be surpassed. Time was a also a constraint because of the dates of the cargo. Macromedia was used because of the many variation of presentations it makes possible and the animations will run using Macromedia Shockwave on any platform. It allows one to synchronize music with animation and attach behaviors to the sprites. When the local animation and graphics experts were consulted, they said Macromedia Director was the best product currently available for doing this type of animation. Planes, tanks, and people were imported into Director with the use of Adobe Photoshop. These imported pictures became cast members for the movie. Then sprites were created and to each of them was attached a script. "Sprites are objects representing when, where, and how cast members appear in a movie." [Macromedia 1997]

The KTS animation started with one plane and one ship and evolved to two planes and one ship. The cargo and people is given in a sorted list by cargo slack time.

Cargo Slack Time = Latest Arrival Time - Available to Load Date

The cargo and people with the shortest cargo slack time are allocated to transportation resources first. Cargo is loaded onto the plane and ship according to the available date of the package, the earliest arrival date and the due date.

There are two thick black lines on a days grid that moved closer together to show the range of time it can schedule the cargo on a plane or ship. These lines represent the window of availability. As additional cargo is added going to a plane or ship the relative scheduling flexibility is constrained. The schedule is further time constrained for each trip as additional cargo is added. In this mode KTS tries to minimize the airlift and sealift assets required. In the animation, the two thick black lines bounding the time of the trip moved closer together as more cargo was added to show the amount of trip slack time for the trip. When a piece of cargo couldn't fit in between the thick lines, trip slack time, then a new plane or ship was created and the cargo was scheduled onto it.

The QCP problem has been used to test combinatorial problems. I am told the search space for an N by N quasigroup is $(N*N)^N$ which make the problem intractable. In the QCP animation problem there was a 3 by 3 grid of squares. Each square had to be filled in with one of three different colors. In each row or column there could be no two colors the same. Backtracking and propagation were animated to fill in all the squares in the grid. Backtracking occurs when two of the same colors ended up next to each other. The animation says "No Solution" and then go back up the tree to untried feasible solutions might exist. If there were no solution down the next path then it would back track again. In this diagram there were obstacles to work around. Two squares in the quasigroup were predetermined. The square in the top right was black and the square in the middle was light. The other colors had to fill in the squares and work around the set colors.

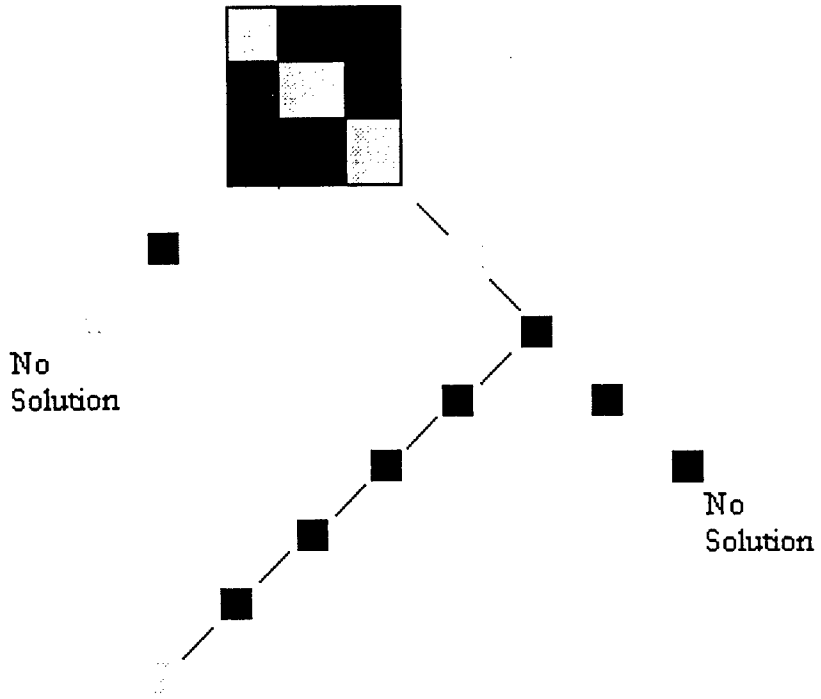

Figure 1 QCP Backtracking

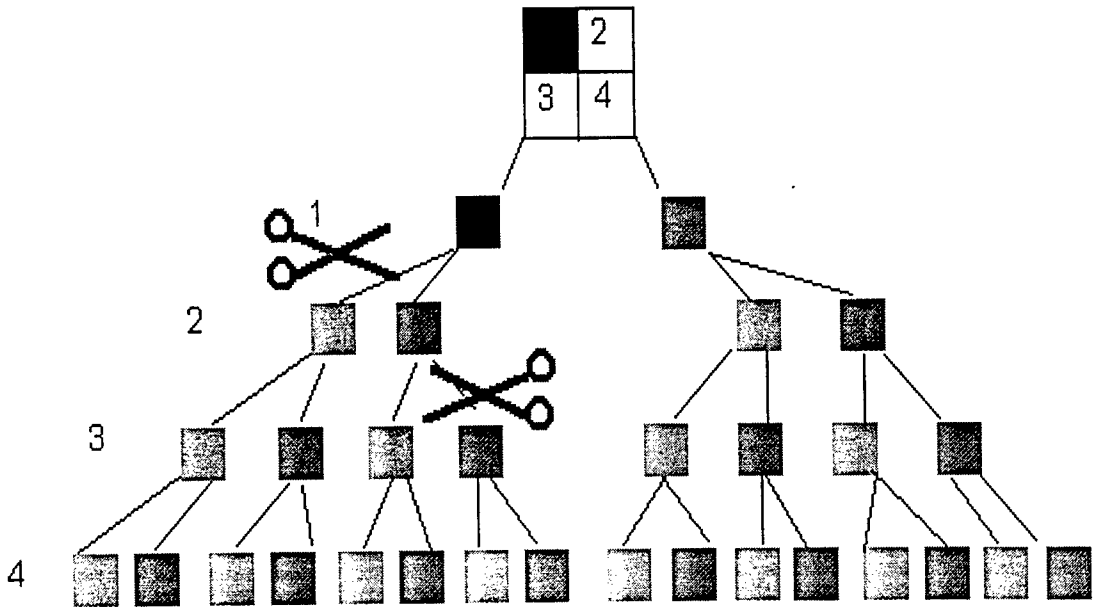

Figure 2 QCP Propagation

Propagation was shown in a 2 by 2 grid. When the first box in the grid became medium the color of the second and third box immediately had to be black because two of the same colors aren't allowed in the same row. The scissors are propagating the red branches because those solutions are no longer feasible. The Global Search Algorithm was shown in this problem by the narrowing down of the choices of color.

Results

While doing each of these animations several problems were encountered. The air/sealift animation had too many constraints that were very difficult to visualize at the same time. It was very confusing when working with the slack time because it could have been viewed in different ways. Dr. Carla Gomes had several ideas for it, but she was only in the area about once a week. In the QCP, Dr. Carla Gomes wanted a three by three Latin Square to display the propagation but when the math was done we discovered it would take over 19,000 nodes. Since our stage, the name of the screen that our animations were done on, is limited to 120 sprites we decided against the animation. Carla Gomes also wanted a tree diagram showing the propagation for the air/sealift problem on a baby problem but again because of the limitations of 120 sprites the tree wasn't possible.

Summary

After much thought and many trials, the air/sealift problem and the QCP were successfully animated. All aspects of KTS were not animated including weight, space, and connecting flights. Each project had to be restarted several times because of the different input and ideas from different people. The global search algorithm was made easier to understand and the animations help make it very clear. The animations were successful and everyone who has seen them has been impressed.

Acknowledgements

I'd like to thank Al Frantz for all of the help, time, and advice he gave me. I'd also like to thank Dr. Carla Gomes for her many ideas and input. They made this summer a great learning experience and lots of fun. I'd like to thank AFOSR and the Air Force Research Laboratory for maintaining a summer study program to allow High School Students to experience a Laboratory environment.

References

[Macromedia 1997] Macromedia Inc., *Macromedia Director 6 Using Director Manual*

[Smith and Parra, 1993] Douglas R. Smith, Eduardo A. Parra. Transformational Approach to Transportation Scheduling. In *Proceeding KBSE '93, The Eighth Knowledge-Based Software Engineering Conference,* pages 60-68, Chicago, Illinois, September 20-23 1993.

VISUALIZING MULTIPATH WITH POV-RAY

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
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Bolling Air Force Base, DC

And

Rome Laboratory

August 1998

VISUALIZATION OF MULTIPATH WITH POV-RAY

Todd S. Burnop
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Abstract

Using rendering software known as POV-Ray to simulate amounts of multipath that occur at test sights like Newport New York, and Stockbridge New York. By obtaining modeled data of the Newport site and importing said data into POV-Ray; virtual models of the site could be created. By adding actual aircraft data as well as simulated radio signals multipath occurring at the Newport sight could be visualized. This data can then be used to limit the amounts of multipath coming from ground positions by the addition of reflection fences and/or ground resculpting.

VISUALIZATION OF MULTIPATH WITH POV-RAY

Todd S. Burnop

Introduction

Multipath has plagued communications between aircraft and surface communication centers since the introduction of radio waves for communication. The main focus of the Stockbridge and Newport test sites is to determine where multipath occurs on an aircraft while in flight by mimicking various in-flight aircraft maneuvers. During this project, various problems with multipath signals from surface areas around the aircraft have interfered with the information being received. To alleviate these problems ray tracing software known as POV-Ray came into use.

Methodology

By using the lines of code native to POV-Ray beams of light can be created and visualized on a monitor. By adding highly reflective models of aircraft, landscape, buildings, and parabolic dishes then placing them into this environment, light reflections on these models can be seen. These reflections of light are the simulated multipath emanating from the various objects that exist in the environment. Since both light and radio are waves they behave similarly at low and high frequencies. By using contrasting colors for each model and for the light the reflections from each object can be seen. By adding or subtracting landscape and reflection fencing the amount of multipath arising from the surrounding landscape can be regulated. This allows for true data of multipath caused by in-flight aircraft to be measured.

Results

To test the original theory proposed by Daniel Warren crude models of the F-16 and F-22 were created using simple geometric shapes. 1/48-scale models of the F-16 and F-22 were obtained. From these models scale drawings from various perspectives were constructed. These were then broken down into

basic shapes consisting of grouped cones, cylinders, 3-D polygons, spheres, and boxes. These shapes were then added to the POV-Ray environment using POV-Ray specific code *(See Below for code snippet).*

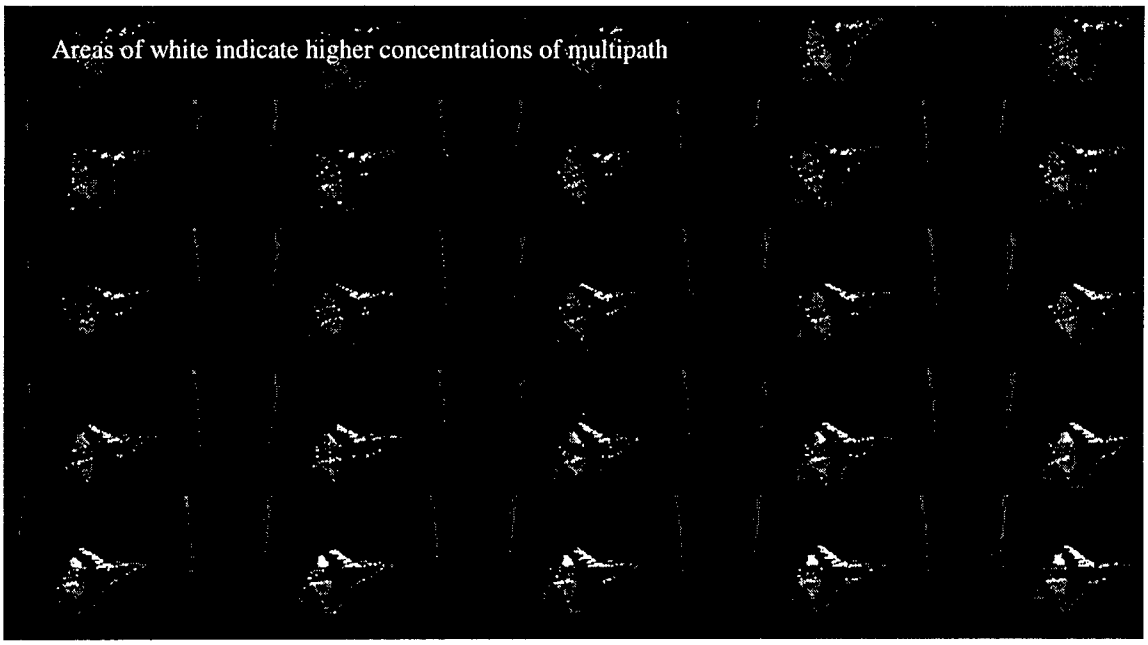
Code Snippet used to create a blue sphere in POV-Ray

```
#include "colors.inc"          // These are library files included with POV-Ray
#include "shapes.inc"          // They define basic shapes and colors

camera {
        location < 0, 0, 10 >
        look_at < 0, 0, 0 >
        angle 90
}

light_source {
        location < 0, 10, 10 >
        rgb < 1, 1, 1, >
}

sphere { < 0, 0, 0 > 2 pigment {Blue }}
```

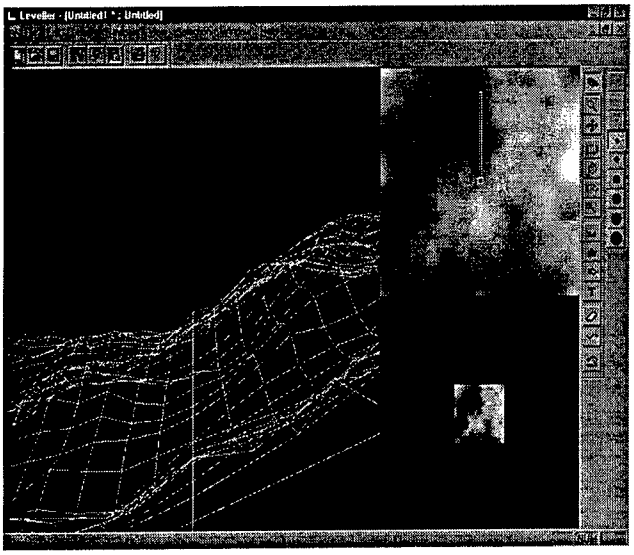
By grouping basic objects together using a union command they can be moved, rotated, translated, and scaled together. The models of the F-16 and F-22 were placed at a distance from the visible light source, a red sphere. Due to the fact that both radio and light are waves they behave very similair. These crude models were then rotated about the origin replicating the movements of actual aircraft at Stockbridge and Newport. For each degree of movement produced by the model a TARGA[1] file was generated. Using third party software each of these TGA files were compressed and added into an animated GIF[2] file format. This proved to be the most effective format so the next phase of the project could be begun. The next step in the project was to get actual aircraft data into POV-Ray. Using a few file converters found freely on the web an IGES[3] file of the Global Hawk was converted to a triangle mesh for use in POV-Ray. The extensive file took hours to convert to POV-Ray code but with its completion actual CAD data could now be used in POV-Ray. A run through of the Global Hawk in the simulated environment produced interesting results. Multipath lit up the aircraft at certain yaw and pitch degrees. From these large amounts of TARGA files

[1] Graphics File Extension TGA, used by various platforms including PC, and UNIX stations.
[2] Another Graphic File Format, often times used for animations on the World Wide Web.
[3] CAD File Extension IGS, standard file extension for most CAD software.

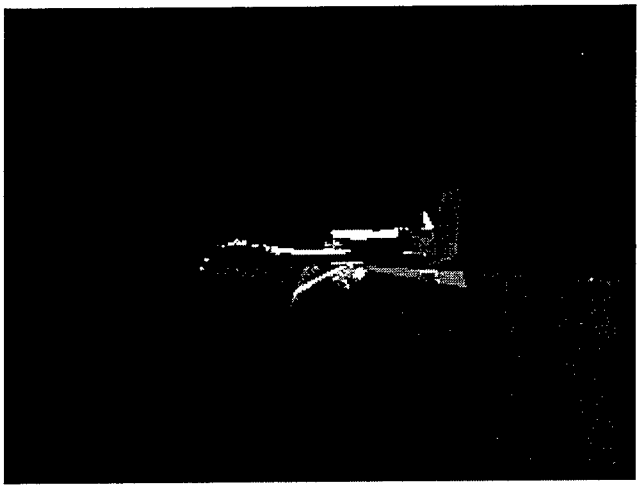
animations of this aircraft were created. For ease of view these animations were placed on a simple web page created specifically for this purpose and only viewable from on base. Next the landscape surrounding the simulated environment had to be modeled. Third party software named Leveller, designed for use with POV-Ray, was discovered while searching the web. This replaced the idea that the landscape had to be modeled using mathematical formulas. Leveller allowed height fields to be modified in real time. Using Leveller and some topographical data of the Newport site, a simple model of the terrain was fabricated. Later a positioner was also included into the environment. Actual CAD data of the F-22 was later obtained and converted to POV-Ray. With these various models available, the terrain, F-22, and positioner were placed into the simulation. Animations of the F-22 were created and a new, more aesthetic, web page was created. Using the data obtained from this simulation, trouble areas on the terrain around the Newport site were found. Later a more precise model of the terrain had to be used. Using a newer build of Leveller, a USGS DEM[4] of the Newport site was ported to POV-Ray mesh. This file however, was of too poor of quality to be of any use. Once a better resolution of the area can be obtained, it can be ported to POV-Ray and used in the simulation. *(Below are still screen captures of the F-22 animation)*



[4] USGS, DEM- United States Geological Survey, Digital Elevation Maps



Screen shot of the Leveller Program



Still of the Global Hawk Animation, white areas indicate high multipath.

Conclusion

By simulating the Newport and Stockbridge test sites on computer, not only are we able to visualize the multipath from the ground and aircraft, but we are also able to add reflection fencing and sculpt the landscape in this virtual world. Thus reducing costs by discovering where the multipath comes from before actually changing the landscape. This allows changes can be based on fact not assumption.

A STUDY OF PROGRAMMING AND IVIEW 2000

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

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August 1998

A STUDY OF PROGRAMMING AND IVIEW 2000

Stefan Enjem

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Abstract

I have studied the X-Windows libraries and JavaScript over the summer of 1998. I used X-Windows to manipulate the program IVIEW 2000. IVIEW 2000 is a government program that is used to visualize air engagement simulations and track certain objects within a graphical interface. The intention of this project was to change the original 2-Dimensional view into a 3-Dimensional view, to be used with polarized glasses. Although my time expired before the project was completed, I have gained knowledge in certain subjects of programming that can be used in my future.

INTRODUCTION TO THE IVIEW PROJECT

X-Windows and MOTIF were used for editing a government program called IVIEW 2000. This government program is used to visualize air attack scenarios, involving a number of different air force fighter planes. IVIEW consists of a viewing window, a graphing window, playback controls, as well as a file menu that allows one to load different scenarios. This program proves to be very useful for the Air Force.

Another summer hire and I had an assignment to change the interface of IVIEW 2000 from its original 2D interface to an all new stereoscopic 3D interface. Unfortunately, one summer was not enough time to complete this task. Although we ran out of time, we did gain a great amount of knowledge on the X libraries and the way this government program executes.

OBJECTIVES:

(1). Remove the control panel from the left and right eye viewing windows.

(2). Link the left and right eye windows to be controlled by the main viewing window.

(3). Put the "eye windows" on a display other than the main window. This would be useful for controlling the stereoscopic viewing from a separate computer so the viewers don't have to be concerned with the controls.

(4). Offset one of the "eye windows" by a certain degree, so the windows can be **polarized*** to create a 3D experience.

(5). The final result that was intended was to be able to project the government program, IVIEW, on a screen. Then the application

would be viewed with the polarized glasses to show the fighter planes using three dimensions.

Note:** ***Polarization is the act of filtering transverse light waves. Light waves travel in vertical and horizontal paths. Polarized glasses, also known as 3D glasses, are used to segregate these light waves. One eye of the glasses filters the vertical transverse waves, while the other eye of the glasses filters the horizontal transverse waves. When the glasses are in use they trick the human eye into seeing 3D images.

In one of my earlier test programs I created a window with a "push" button. For such a simple task, this program uses quite a bit of MOTIF and X library coding. The code is as follows:

```
/* These "#include" statements are the libraries needed to perform the
operations executed in this program */
#include <Xm/Xm.h>
#include <Xm/PushB.h>
main(int argc, char **argv)
{   Widget papa_wid, button;   /* These are the declarations of the
        XtAppContext  app;   variables used throughout the program */
        void pushed();
        papa_wid = XtVaAppInitialize(&app, "Push", NULL, 0,
                &argc, argv, NULL, NULL);              /* This is needed to
                                                       initialize the application
       button = XmCreatePushButton(papa_wid, "Push me", NULL, 0);
      /* This tells the Xt libraries to manage the button */
     XtManageChild(button);
    /* This allows the function pushed to execute correctly  */
        XtAddCallback(button, XmNactivateCallback, pushed, NULL);
    XtRealizeWidget(papa_wid); /* This displays the widget hierarchy */
```

```
XtAppMainLoop(app); /* This enters processing loop that runs the
application */
}

void pushed (Widget w, XtPointer client_data,
                XmPushButtonCallbackStruct *cbs)
{   printf("Don't Push Me!!\n"); }          /* This is outputted to the
```
standard output screen every time the button is pushed. */

The IVIEW 2000 program proved to be very complicated in structure. The object, source, and executable files, alone took up 220 megabytes of hard disk space. What made this more frustrating was the fact that the commenting of the code and the documentation was extremely poor. It took weeks to dissect the code and figure out what C files we were to deal with. After drawing out the directory structure we attempted to begin the difficult task of "hard coding" our ideas into their code.

In order to complete our job we were to make three separate windows. The windows would be connected together, using the main window to control all three of the windows. The other two windows would be used for right and left eye viewing in the stereoscopic environment. This would be done by offsetting one of the "eye windows" by a certain degree. We learned how to create new windows, but that obviously was not enough to accomplish our goal. We had to connect all the windows so they could communicate with each other; this is what took the most time. We trouble shot this problem for many weeks and could not seem to come up with the final results that we wanted.

In our first approach we made the three windows using the following code (there were four separate files that we imported our code into for this operation):

(1). THIS CODE WAS PUT IN THE CALLBACK FILE:

```
XtCallbackProc
MW_ViewingCB( Widget w, XtPointer cd, XtPointer cld )
{
/* This is creating the new_class class */
    WindowClass * new_class =
        WNM_CreateWindow( theWindowManager,
                          WNM_VIEWING,
                          IDB_AllocateNext( theIDBroker ) );
/* The IDBroker gets a different id for each window */

    WindowClass * leftEye_class =
    WNM_CreateWindow( theWindowManager,
                          OUR_LEFTVIEW,
                          IDB_AllocateNext( theIDBroker ) );

    WindowClass * rightEye_class =

        WNM_CreateWindow( theWindowManager,
                          OUR_LEFTVIEW,
                          IDB_AllocateNext( theIDBroker ) );

    if ( new_class )
    {
        new_class-> Popup( new_class );
    }
    else
        printf( "\nCould not create a new Viewing Window." );
```

```
    if ( leftEye_class )
    {
            leftEye_class-> Popup( leftEye_class );
            printf( "\nLeft eye window just created." );
    }
    else
        printf( "\nCould not create Left Viewing Window." );

    if ( rightEye_class )
    {
            rightEye_class-> Popup( rightEye_class );
            printf( "\nRight eye window just created.\n" );
    }
    else
        printf( "\nCould not create Right Viewing Window." );
}
```

/* The code above for the most part is self-explanatory. What this segment does is the following: (1) Creates three windows (right, left, and new), (2) Then it pops them up and prints a statement letting the user know everything executed as planned, (3) If something did not execute correctly it prints a different statement to the output screen. */

(2). THIS WAS PUT IN A DIFFERENT FILE TO CREATE THE LEFT EYE VIEW:

```
ViewingWindow *
VW_LeftEyeCreate( Widget parent, long win_id )
{
    ViewingWindow * this = NULL;
```

```
    if ( this = (ViewingWindow *) malloc( sizeof(ViewingWindow) ) )
    {
        if ( VW_buildLeftEyeInterface( this ) == FAILURE )
/* In this statement the control panel creation has been removed */
        {
            if ( this-> shell ) XtDestroyWidget( this-> shell );
            free( this );
            this = NULL;
        }
        else
       /* This executes if the window was not initialized correctly.  If this
is the case it kills the window */
       {
            if ( VW_Initialize( this, win_id ) != SUCCESS )
            {
                VW_Destroy( this );
                return( NULL );
            }
        }
    }
    return( this );
}
/* This above segment creates the left eye interface and creates our new
viewing window.  This function is used for both, the right and left eye
views. */
```

(3). DEFINED IN A DIFFERENT FILE:

```
#define OUR_LEFTVIEW    12
```

(4). ADDED THIS CASE STATEMENT:

```
switch (win_type)
case OUR_LEFTVIEW:
        {
            WindowClass * new_win =
              (WindowClass *) VW_LeftEyeCreate( (Widget) NULL, win_id);
            if (new_win)
               LL_Prepend0( this-> viewing_windows, (void *) new_win );
            return( new_win );
        }
        break;
    }
    return( (WindowClass *) NULL );
}
/* The code above checks to see if the window is created with OUR_LEFTVIEW.
If it is, then the function is executed. */
```

One of our objectives was to remove the control panel from the right and left eye viewing windows. The code above accomplishes that; however, when the viewing windows are created, they reference the control panel. This, unfortunately, causes IVIEW to function improperly. Without the control panel many other functions do not operate correctly. IVIEW first will not redraw its windows and then it will proceed to crash.

CONCLUSION OF THE IVEW 2000 PROJECT

Despite our unsuccessful research and infinite trials with the IVIEW application, I learned how real programs function and how complex they can become. This is a very significant characteristic of programming to be aware of.

Time is also of the essence if you are a programmer for a company. Before starting a project you should figure out the amount of time you have and break your big goal up into smaller goals. Even though I used this technique, the complications that I ran into ended up becoming too time-consuming and the project was much bigger than what was originally expected. This research proved to be extremely worthwhile due to the information that I have learned about the X-Windows libraries, and project management in general. I am fairly confident that I know how these libraries function and how they respond to certain changes in code.

INTRODUCTION TO MY JAVASCRIPT RESEARCH:

JavaScript is a scripting language that is used worldwide. It can be used for anything from making games, to changing the graphics on a page at any given time. Almost every major site that you will visit while surfing the web usually has some form of JavaScript on it. I experimented a great deal with JavaScript. Upon researching its capabilities, I found it very useful and observed how it can extend an HTML document.

JavaScript allows one to use many of the C language's attributes. Some of these attributes include: (1) Arrays, (2) Variables and (3) Print statements. The onMouseOver and onMouseOut functions can also be used to make images change as the mouse is moved over them, etc. These functions are

called a little bit differently than the way they are called in C, however they still have the same effect.

JavaScript can also imitate CGI-scripts. CGI-scripts are used for things like, taking surveys and asking visitors for their e-mail addresses. JavaScript will allow one to compose forms and other such input devices on web pages without the use of a cgi-bin. This scripting language seems to be the most lenient out of all the languages that I have experienced. If you forget certain details while coding, the browser can usually figure out what you were trying to do. Although this may seem like a vast improvement over other languages, it can be a disadvantage as well. If code becomes too messy, debugging can take hours. Despite the leniency of this scripting language, I found it advisable to be as uniform and consistent as possible. This can save literally hours of debugging time.

Here is an example script that randomizes a graphic every time the page is loaded on a Monday [Doing it for the other days of the week would merely involve simple cutting and pasting].

```
<HTML>
<HEAD>
<TITLE>Is it Monday?</TITLE>
<SCRIPT LANGUAGE="Javascript">
<!--
function RandImg()
{
            var Monday = new Array();
            Monday[0] = "monday.gif";
            Monday[1] = "monday2.gif";
            Monday[2] = "monday3.gif";
            Monday[3] = "monday4.gif";
            Monday[4] = "monday5.gif";
```

```
            // Get Array Index
            var gifInd = Math.floor(Math.random() * 4.99999);
            // Get day of the week
            var theDate = new Date();
            theDay = theDate.getDay();
            if (theDay == 1) {
// This gets the random image and links it to the Garfield webpage (Garfield
graphics)
                        document.writeln("<A
HREF=\"http://www.garfield.com\"><IMG SRC=\"" + Monday[gifInd] + "\"></A>");
            }
            else {
            //If it is not Monday then this statement prints
            document.writeln("Reload this page on Monday");
            }
}
//-->
</SCRIPT>
</HEAD>
<BODY>
<SCRIPT>
<!--
//Calls the function from the body
RandImg();
//-->
</SCRIPT>
</BODY>
</HTML>
```

CONCLUSION OF MY JAVASCRIPT RESEARCH

JavaScript is a good thing to know if you are interested in web editing, and I suggest learning it. If however, you don't have the time to learn it, there are many pages on the Internet that offer free capable of doing just about anything you can imagine. If you get really good you can combine more than one script and make professional-looking pages.

CONCLUSION OF SUMMER RESEARCH

This summer's research project was much more challenging than last year's project. Being challenged is one of the things I liked most about my research this summer. Besides what I have mentioned above, I also have gained some knowledge with the Unix operating system as well as its popular editing program called VI. JavaScript and the X libraries are both universally compliant with almost all operating systems. This makes these languages very useful for any platform that I may be using in the future. I know that the areas I have covered this summer will become very useful for me as I make my way to college.

IVIEW 2000 UPDATE

There has been many significant advancements since the publishing of this report. We have accomplished connecting the two "eye windows" together. We edited the callbacks in the code, so both windows are updated when the control panel is used. To do this we had to call the callback three times; one time for each window (main, left, right).

This is probably the biggest breakthrough all summer. Now that the two windows can communicate together, we are much closer to our final goal of creating a stereoscopic environment. We will now proceed to offset the two windows so they can be viewed with the polarized sunglasses. After this step is done we will create the new display for the "eye windows". This will be done so we can project the two "eye windows" on a screen, while they will be controlled from a different computer that is not seen by the viewers.

THE DEVELOPMENT OF WEB PAGES FOR THE AIR FORCE RESEARCH LABORATORY INFORMATION TECHNOLOGY DIRECTORATE

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Rome Laboratory

August 1998

Michael Favata

Abstract

This report details my activities at the Rome Research Site of the Air Force Research Lab to develop web pages. I developed my Web Tools program to aid me in my task of creating web pages more efficiently. Making use of a 3 dimensional rendering program dramatically increased the quality of the graphics I created for the pages. I also expanded my programming knowledge by learning a portion of Java during my tour.

THE DEVELOPMENT OF WEB PAGES FOR THE AIR FORCE RESEARCH LABORATORY INFORMATION TECHNOLOGY DIRECTORATE

Michael J. Favata

Introduction

Today, the World Wide Web (WWW) is growing exponentially as the number of users flock to their ISP's (Internet Service Providers) in pursuit of the "web surfing" experience. It can be said that there is a mathematical relationship that relates the number of WWW users to the demand for people who make the whole concept of the Internet and WWW possible. It can be said that the mathematical relationship is direct in nature. As the number of users increases, the demand for technically skilled workers increases to keep up with the increase in complexity of the Internet and WWW. These technically skilled workers have knowledge and experience in such areas as, telecommunications, computer programming, graphics development, networking, science, and mathematics. Each and every area of expertise plays an important role in the development of the Internet and WWW, and ultimately the development of our nation in general. The most basic concept for development on the WWW involves making a web page using the HyperText Markup Language or HTML for short.

As emphasis on the World Wide Web increases the importance of web page development for the Air Force increases. The Air Force recognizes the importance of this new publishing medium for communicating Air Force technology to DOD customers and the public in general. Thus AFRL/IFTE has committed significant resources to web site development and summer students contribute to these resources.

The Problem

I was faced with several problems this year in high school. One of which was to create an HTML editor / web browser to aid in my task of web page development. In order for me to complete this task I had to learn the Visual Basic programming language. Once I had obtained a good understanding of the language I was able to successfully develop my program. My next problem presented itself when I started working at the Rome Research Site in the IFTE branch. The reorganization of AFRL caused the obsolesce of many pages, need to convert existing pages, and need to create new pages. My task was to aid in the development of the Rome Research Site web page. In order to complete this task I had to use my knowledge of HTML.

Methodology

With the aid of my communication skills I was hoping to get a feel for the atmosphere at the Rome Research Site. I was hoping to obtain information and concepts on how the web page was supposed to look and the information it was to contain. Once I had this information I could use the newest version of my Web Tools program to create new pages, and modify existing ones based on the information I had received.

I also had to obtain knowledge of how the Rome Research Site network was laid out, the various servers for the Internet, extranet, and several others. This knowledge would be essential to my task because I needed to know where the pages were to go once they were completed. I was required to meet with the Web Office every Wednesday in order to get coordinated with what all of the other summer students were doing on the web page. I could also get some direction from the Web Office if needed.

With all of these things comes a set of procedures that needed to be followed when working on the Rome Research Site web pages. You were required to acquire a public approval number from Public Affairs on any page that was ready to be uploaded to the web server. There was also a Web Lint program that needed to be run on the pages. The task of this program was to detect any error in the web templates and notify the user if there were metatags that needed to be filled in.

Results

I am very pleased with the results of my tour because of what I have accomplished. I have created several web pages with content dealing with IFTE's lab equipment. The pages contain facts about the equipment along with specifications and payoffs. A few examples of these pages are attached.

Along with my task of creating or modifying web pages came a new challenge. The Web Office approached me and I was asked to create an image map for a web page they were putting together. I relied on my graphic skills to take me through this challenge. I used a program called Bryce 3D by Metatools to make the main image to be used in the map. Bryce 3D is a three-dimensional rendering and modeling program that can be used to create relatively simple or complex 3d rendered images. Since I have had about a year and a half of experience using this software I was able to take advantage of its features. When I had rendered the image I had to further modify it by inserting text using Adobe Photoshop. The following image (Figure 1) is what the finished image map looks like.

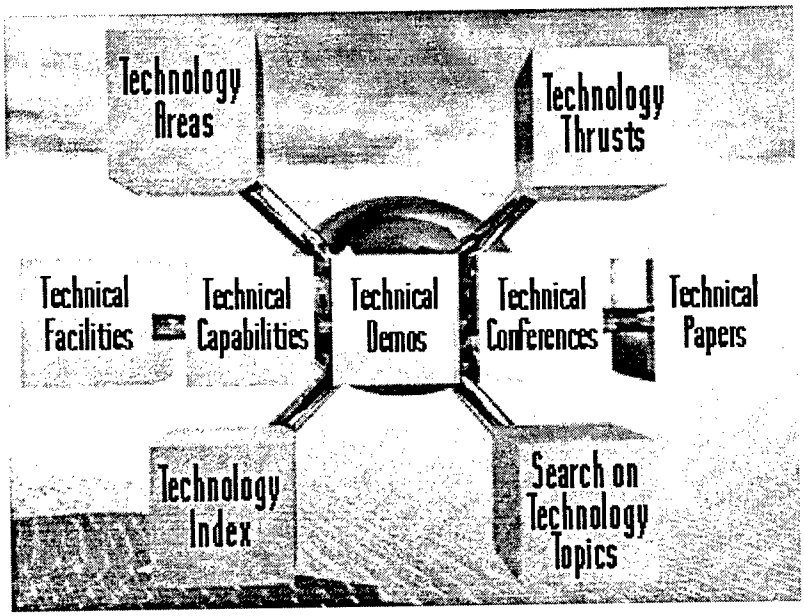


Figure 1. IF Web Office "Orb" Image Map.

Another individual also approached me and requested that I create a title graphic to the Formal Methods program. The program had to do with logic so I used Bryce 3D to create 3d models that represented logic symbols. With the additional use of Adobe Photoshop I was able to insert the "Formal Methods" title into the graphic. The graphic looks as shown in Figure 2.

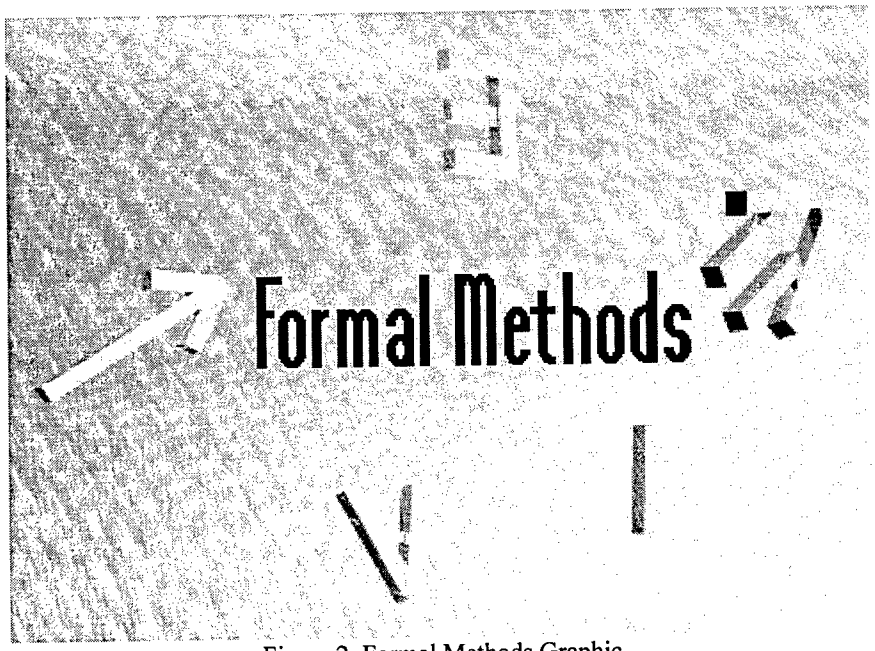
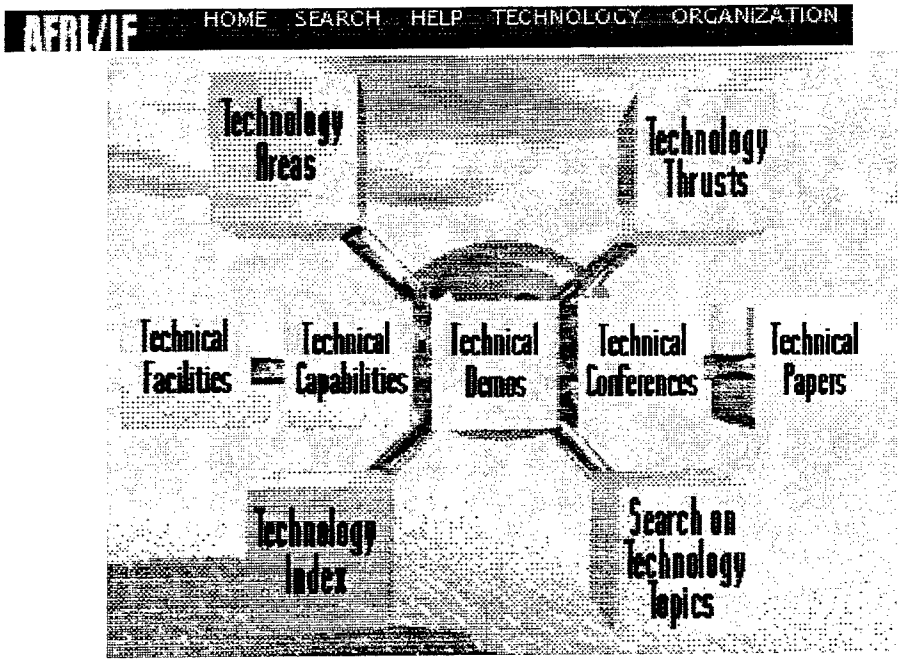


Figure 2. Formal Methods Graphic.

During the times where I had a shortage of work that needed to be done I continued developing my Web Tools program and I also furthered my education by learning a good portion of Java. By learning Java and further developing my Web Tools program I was able to enhance my abilities in producing web pages. By further developing my Web Tools program I was able to make various tasks easier to accomplish and therefore increase output and decrease development time. I feel I have made a significant contribution to the lab because they can now take advantage of the features in my Web Tools program.

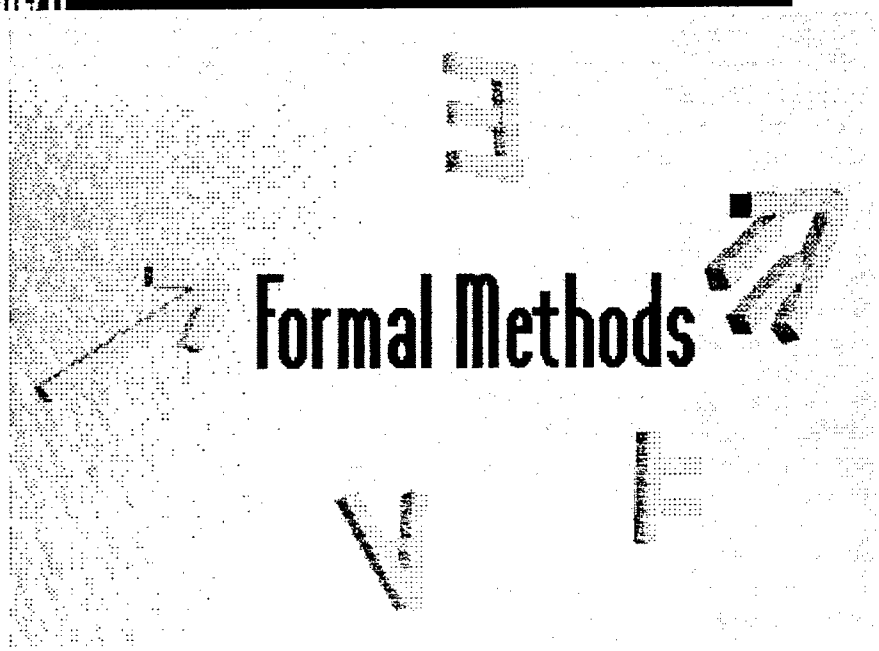
Conclusion

In conclusion, developing my Web Tools program greatly aided in my task of writing web pages and helped increase my knowledge of programming in Visual Basic. Clear and organized web pages are important for communicating AFRL technologies to DOD customers and the general public. Developing new web pages is a slow process, particularly follow a major reorganization. A good knowledge of programming tools is important for the creation of intricate web pages.



Last Updated: 23 January 1998

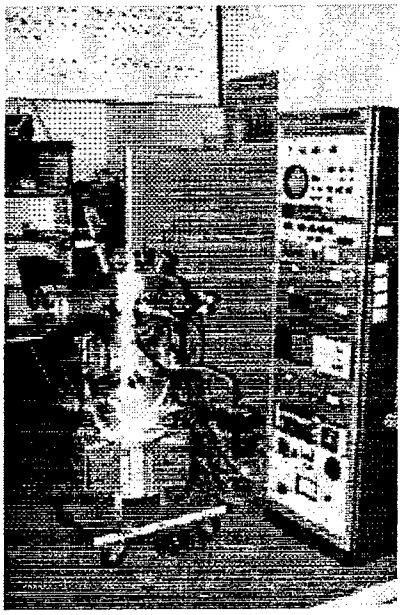
program email
Technical POC email



Last Updated: 23 January 1998

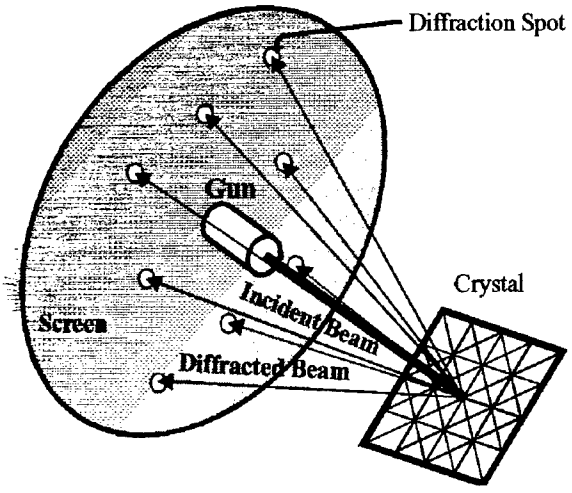
webmaster email
Technical POC email

AFRL / IFTE LOW ENERGY ELECTRON DIFFRACTION (LEED)



DESCRIPTION:

Low energy electron diffraction, (LEED), is used to examine the surface crystallography of materials. It provides information on the first few atomic layers including surface reconstruction due to lattice relaxation, specific lattice adsorption sites, and two dimensional ordering characteristics. Metals, carbides, semiconductors, oxides and layered compounds can all be examined with LEED. The surface crystal structure of materials differs from the bulk lattice. LEED provides the relaxed or reconstructed lattice parameters and shows the positions assumed by adsorbed materials such as oxygen, hydrogen, or other materials undergoing catalysis in surface reactions.



In low energy electron diffraction, the material examined is bombarded, under high vacuum, by a low energy electron beam. The electrons that penetrate beyond a few atomic layers do not have enough energy to escape again. Only the electrons that reflect form the surface layers escape to be detected. At very specific angles, the beam will reinforce itself and diffraction occurs. The pattern of diffraction spots is analyzed to determine the crystal structure, atomic positions, and lattice dimensions. This pattern is obtained by photographing a fluorescent screen.

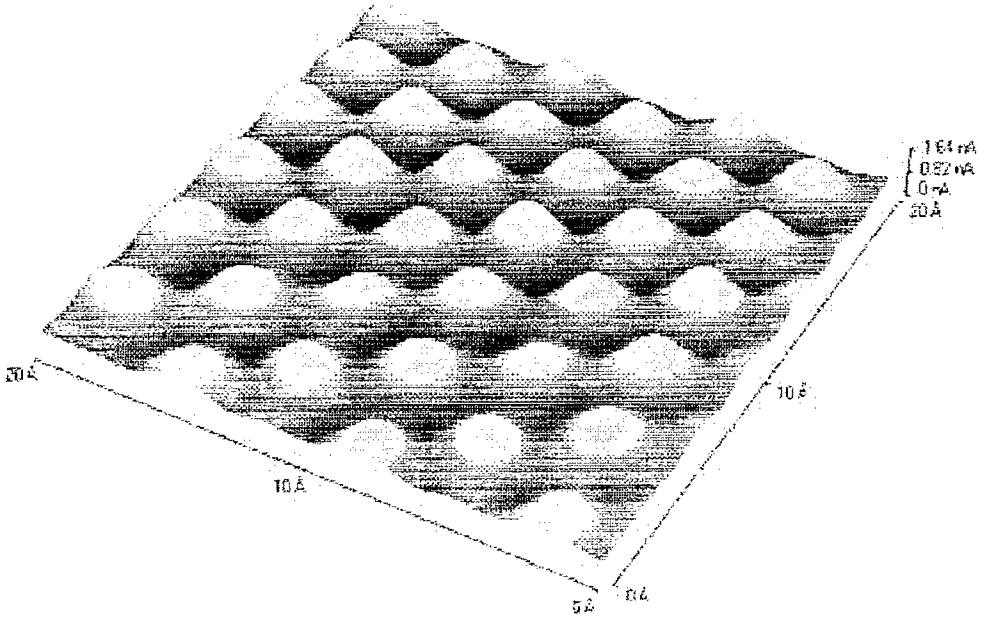
PAYOFFS:

Last Updated: 23 January 1998

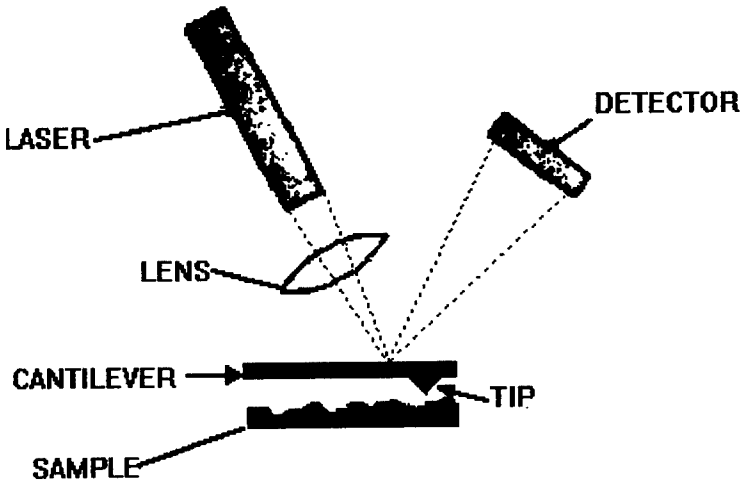
AFRL / IFTE SURFACE PROBE MICROSCOPY FACILITY

DESCRIPTION:

Surface Probe Microscopy (SPM) is a surface analysis technique based on the interaction force of a microscopic probe with the surface of the sample under investigation. SPM is applicable to the study of insulators, semiconductors, and conductors. This technique has subatomic (better than 0.1 Å -- greater than 10,000,000X) resolution and can quantitatively determine surface topography in 3-dimensions. The SPM is a technique capable of analyzing materials in their native state with high relative and absolute resolution.



SPM traces the vertical movement of a microscopic probe attached to a cantilever beam as it is scanned across a specimen's surface. The output signal is a voltage generated by a focused laser beam reflected off the back side of a cantilever into a differential detector. This voltage is proportional to the interaction force and the vertical motion of the cantilever. The interaction force is used to map and analyze surface structure such as: grain size, grain size distribution, step heights, metallization thickness, and surface roughness.



PAYOFFS:

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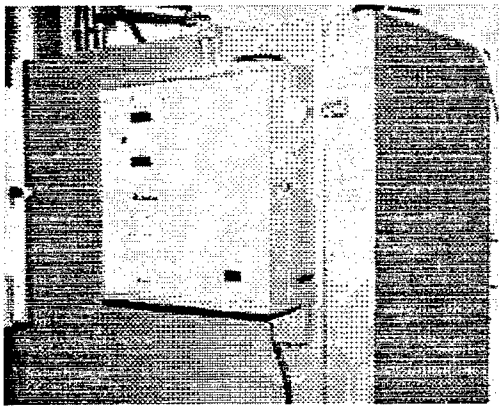
Webmaster email
Technical POC email

AFRL / IFTE TEMPERATURE / HUMIDITY CHAMBER



DESCRIPTION:

The Tenny Thirty is a 90x90x100 cm temperature / humidity chamber used to study the effects of various stable temperature + humidity conditions on products. Electrical feed-throughs allow for electrical biasing and monitoring during test. The temperature can be set to between -65 and 200°C + or - 5°C, and the humidity can be set to between 30 and 95% RH + or -5% RH.

PAYOFFS:

Last Updated: 23 January 1998
Webmaster email
Technical POC email

The Study of United States Cellular Technology

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Final Report for:
High School Apprentice Program
Rome Laboratory

August 1998

The Study of United States Cellular Technology

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T. R. Proctor High School

Abstract

Cellular Technology was researched and studied. The three main the three main technologies studied were AMPS (Advanced Mobile Phone Service), GSM (Global System for Mobile Communication), and IS-95, a code division multiple access based standard. The research was done mainly with the use of books, articles via the Internet, and by visiting cellular providers in person. In the research the technologies were compared to see which one had the better advantages and prevail in the long run as the new standard. IS-95 was found to be the best.

In addition to the research I started to explore MATLAB®. I was introduced to the program in the beginning of my research and was taught how to write my own programs and presentations using MATLAB®.

INTRODUCTION

Cellular communication has grown rapidly. People today don't have the mobiles just for business, but some have them as their only phone service. In light of this boom in cellular usage providers need to think of ways to increase the quality and capacity of their services. Many new advances have been made from the original AMPS cellular system. Two of which are GSM and IS-95.

The three cellular technologies were researched and compared. They were AMPS, a frequency division multiple access system, GSM, a frequency division and time delay multiple access system, and IS-95, a code division multiple access system. All of the three technologies serve their purpose well but which one is the best is what the following will show.

There will also be a brief section on what was learned about MATLAB®.

DESCRIPTIONS OF CELLULAR FORMATS

IS-95 (Code Division Multiple Access)

The first of the three cellular technologies is IS-95 (CDMA). IS-95 utilizes a spread spectrum waveform. Spread spectrum communication has been used roughly since fifty years ago. The military utilized this type of communication because of its secrecy. Spread spectrum communication is hard to jam and very hard to break in and listen to because the wave that is used for communication has such a wide band. The most important use for the IS-95 format right now is for commercial purposes. Its format promotes multiples of users on one channel. IS-95 is getting quite popular due to the fact that it also is compatible with the AMPS format and allows overlaying right over existing analog channels. To allow multiple users on each channel the mobile's signal is spread by multiplying the narrowband signal with a wideband signal. The wideband signal is generated by spreading "walsh codes", which are 64 "chips" that go with each symbol interval. This sequence of chips is used to modulate the carrier signal during each symbol period, which produces the spread spectrum.

This accounts for three advantages. For one, the spreading sequences are set up so that many subscribers can use the same channel and not interfere with each other. Each signal is spread different enough so that a subscriber receives only the intended call. Second, in light of the wide bandwidth, the IS-95 has much finer delay resolution with multipath signals. The spreading of the waveform is independent of the data or information sent, so accurate combining of multipath signals is possible at the receiver. This is done by the use of rake receivers. In IS-95 these rake receivers are usually a set of four receivers. All the information received is labeled in the way that the information when sent was all lined up next to each other. During the transmission the signal is scattered by deflection and reflection off of anything from buildings to cars and is received as a multipath signal. One of the rakes acts as fingers. One of the receivers constantly searches for different multipaths and feeds the other three receivers. Then each of the receivers demodulates the signals lining them up with a strong multipath and the final signals are all combined to create a stronger final signal. IS-95 actually uses multipath to its advantage. Lastly, IS-95 has immunity to many kinds of interference. This is due to the fact that it operates at a much lower carrier to

interference ratio. In other words the carrier signal of the conversation is at a closer ratio to the interference than GSM or AMPS.

Believe it or not when considered with the Additive White Gaussian Noise channels IS-95 will support less subscribers than GSM(TDMA/FDMA), in the same bandwidth. Certain aspects of the cellular community promote IS-95 to provide a much more efficient service. One example is that IS-95 promotes universal cell frequencies, because the system uses one frequency for all conversations. The common spectrum means that cell division and strategic cell placing because of frequency interference to increase capacity will be eliminated. IS-95 uses one channel, or frequency, to support all of its callers. Another highly regarded advantage is that soft hand-off is possible with IS-95. Soft hand-off is when an IS-95 mobile switches base stations. The hand-off is, well, almost fail-safe. When an IS-95 mobile is in a conversation it is utilizing one base station as its communication to the wireline system but at the same time is communicating with other neighboring base stations while monitoring power levels. When the power level of another base station is more desirable the mobile just switches to the other base station virtually undetected, since it was already communicating with the new base station, without dropping the call. Lastly, it is possible to perform accurate power estimation and closed loop power control, because interference of all types appears noise-like at the base station receiver. This makes it possible to eliminate the "NEAR-FAR" problem generally referred to with IS-95 (CDMA). The "NEAR-FAR" problem has to do with the handoff procedure with IS-95. The problem has been corrected, but when an IS-95 mobile is close to, for example, a base station that someone farther away is using the closer persons signal will drown out the farther and weaker signal and interfere with it. Due to the excellent power control IS-95 mobiles can transmit at minimal power level which in turn increases talk time and/or phone and battery size.

GSM (Time Delay Multiple Access/Frequency Division Multiple Access)

TDMA is a fairly new development in cellular technology. GSM is the TDMA (time delay multiple access) service currently being pushed in the US. In Europe GSM (TDMA/FDMA) has flourished and dominated the cellular market. GSM (TDMA/FDMA) is also a digital system.

In the early 1980's cellular phones were spreading like wildfire in Europe. Problems with compatibility arose. All the countries had different standards, which made roaming a problem and interference increase greatly. In 1982 GSM was made a policy. GSM in 1982 meant Groupe Speciale Mobile. It delegated that cellular providers had to comply with certain quality control and compatibility policies such as good speech quality, low costs, international roaming, ability to support handhelds, and ISDN compatibility. By 1989 GSM(Global System for Mobile Communication) was beginning to be put into service in Europe. This was an actual cellular standard that utilized TDMA/FDMA technology. This is the system that dominates the European market. GSM has recently also been offered in the United States.

GSM employs two technologies FDMA and TDMA. They are used together to form a cellular service with a greater caller capacity to allotted bandwidth

The FDMA(frequency division multiple access) is used just like in the AMPS system. GSM has 25MHz of bandwidth. This bandwidth is divided into 200kHz channels, 124 channels in all. On the top of the frequency division GSM also employs TDMA(time division multiple access). Each of the 124 channels are divided into 8 time slots, each being 4.6 ms long. This creates a total of 1000 speech and data channels for the European GSM. This is a respectable capacity per bandwidth for a cellular service and is one of the reasons the GSM market has exploded in Europe and creeping into the US.

Due to multipath signal arrivals at the base stations and mobiles GSM(TDMA/FDMA) must cut back on interference. While IS-95(CDMA) uses rake receivers to cut back on multipath, GSM can't because of its narrowband system. GSM uses a filter.

Multipath is caused by the deflection of radio waves off of everything from Building to cars. This filter is called multipath equalization. This filter takes a solid usable signal out of all the signals received. The mobile or base station does this by sending a 26-bit long training signal, which is constant for all

mobiles and base stations in the same channel, in the middle of a data transmission. The receiver, being a mobile or a base station, can decipher how the training signal was varied and reorganizes the incoming data inversely to the way the training signal was varied. While rake receivers are the best way to correct multipath, multipath equalization is the best way to correct the problem with a narrowband system such as GSM.

AMPS (Frequency Division Multiple Access)

AMPS (Advanced Mobile Phone Service) is the first cellular standard to be used. It is an analog technology that utilizes only FDMA (Frequency Division Multiple Access). It has been around since the 1930's. It was used in police dispatching and other such tasks. Over the years it has been improved and still exists today as the AMPS system. The AMPS system still services many people in the US. Although, the reason why new digital standards such as GSM (TDMA/FDMA) and IS-95 (CDMA) are being developed and expanded are because of the many problems AMPS possesses. Such problems are interference, dropped calls, and conversation eavesdropping.

The AMPS system is analog and utilizes FDMA (Frequency Division Multiple Access) to get the meager capacity that it has. Since the AMPS system uses FDMA this means that each channel is separated only by frequency, if you have a different frequency then you have a different channel. The channel separation for AMPS is 30kHz. This is also an analog that does not allow encryption for call security. In turn, AMPS leads to avid eavesdropping. Due to its analog system, mobiles and base stations must transmit at high powers to improve voice quality and to reduce interference. This leads to low talk time due to battery drain. This is just one of the problems that will explained about AMPS in the further sections.

COMPARISON AND CONCLUSION

Cellular communication has many problems. In some systems problems are numerous and in others minimal. Which system, AMPS (FDMA), GSM (TDMA/FDMA), or IS-95 (CDMA), has the best outlook when compared to each other. The problems that will be reviewed will be handoff, power consumption, interference, cell configuration, caller capacity, conversation security, and cost of service.

Handoff has always been a big concern in the cellular community. Other problems tag along with handoff such as dropped calls, horrible interference on cell fringes, and rough, noisy handoff procedures when they work. Out of the three cellular configurations IS-95 (CDMA) has the best handoff procedure. When an IS-95 mobile is in use it constantly has communication with more than one base station and monitors the power levels of the base station's communication. Due to the fact that the mobile is connected too more than one base station, when the power level of a new station is of better quality the communication is then transferred to the new station while at the same time using the original base. With AMPS and GSM handoff can be complicated and very unstable. AMPS and GSM have neighboring cells with different frequencies. During handoff with GSM and AMPS the mobile has to switch frequencies from cell to cell. IS-95 has a universal frequency throughout all the cells.

Power consumption of a mobile phone is very important. The power it takes run the mobile dictates the size and weight of the phone and most important the use and standby time of the mobile. Out of the three configurations AMPS takes the most power to run. To get good coverage with little interference the AMPS system must transmit at higher powers than GSM and IS-95. IS-95 uses the least power. IS-95 uses less power than GSM because it has rake receivers to get rid of interference. GSM uses a filter to get rid of interference. The difference is that IS-95 takes all the multipath signals and combines them to form a stronger received signal. In the GSM system the filter must take the strongest signal out of the multipath and reorganize it to from a correct signal, so GSM also needs a good amount of power to transmit from the mobile. In turn the AMPS mobile is the biggest phone with the least talk time. GSM claims to about 1/7 the power of amps and IS-95 is claimed to be 1/1000 the power of AMPS. GSM and IS-95 also have an advantage because they are digital and they have much more advanced vocoders that only record and then transmit when talking, no power is wasted transmitting dead air.

Interference is also a big problem in the cellular community. The AMPS system is the worst when it comes to interference. It has no filters to get rid of multipath and other interference. The AMPS system is strictly an analog signal being received and sent through a FM demodulator, to an amplifier and then to your ear. With IS-95 and GSM there are filters to correct interference digitally. This makes a clear reception of signals and a quality sound for the phone. IS-95 has the upper hand in this situation. IS-95 has two main things going for it. They are rake receivers to correct multipath, and the cells in the system all have the same frequency. The rake receivers take all the multipath signals and combine so they can be used as one signal. This actually uses the interference to create a stronger signal with the rake receivers. All the cells have the same frequency. This provides a better overall coverage. When you are on the fringe of a cell you won't have interference because the mobile may communicate with another base and smoothly hand off to the other station, as opposed to waiting until you are in another cell and having to switch frequencies. GSM uses a filter to control interference. This system works well, the GSM system still is vulnerable to fading, and interference from other cells, around the cell fringes.

Cell configuration is another important key to a well thought out cellular system. AMPS and GSM have to use certain methods of cell separation because neighboring cells cannot have the same frequency or they will interfere with each other and dropping calls and having cross conversation. This is a complicated process especially when cell splitting needs to be done to create more capacity. In the IS-95 system all of the cells can have the same frequency. The reason for this is that IS-95 is a code division multiple access instead of time or frequency division. Since all the cells are the same all that needs to be done is finding out how much power must be used and how big the cells should be. This universal frequency reuse also aids in elimination of interference and handoff. The GSM and AMPS cell configurations work well but can cause problems on the fringes and in handoff procedures.

Conversation security is a big issue for the cellular community. Eavesdropping is the biggest concern. Anyone can listen in on the AMPS system. The AMPS system has no form of encryption because AMPS is analog. All you need is a scanner and you can listen to someone's conversation. It is very easy because the information is sent in the same manor as an FM radio in your car. In the GSM and the IS-95 systems the information is sent digitally and can be encrypted so only intended person can receive

the message or conversation.

The communication of data, such as the Internet has been a big issue with the cellular community. With the AMPS system it is impossible to transmit data because the analog transmission has too much error that cannot be corrected. The GSM and IS-95 systems can transmit data. They are both digital systems that have excellent error correction but they are still slow I the transmission of data in the respect to a modem.

Capacity of the cellular system is of great importance to the provider. They need a system that can provide the greatest possible amount of useable channels to support the growing cellular community. AMPS (FDMA) has the least capacity. GSM (FDMA/TDMA) and IS-95 (CDMA) considerably close in capacity. AMPS relies on frequency division to support multiple users. An example is that for the AMPS system the channel spacing is 30kHz, and for the FCC allotted spectrum AMPS creates 166 duplex channels. GSM uses frequency division and time division. This divides each frequency channel into eight time slots. This allows eight subscribers on each frequency channel. The GSM system currently supports 2000 speech and data channels with a half rate vocoder. The IS-95 uses code division multiple access. Instead of having time or frequency divide conversations each conversation is encoded. This allows multiple use of one frequency channel. According to Qualcomm, the capacity of IS-95 (CDMA) is three times the capacity of GSM (FDMA/TDMA) and ten times the capacity of AMPS (FDMA).

Lastly, for the consumer price is a great concern. The new technologies are supposed to be cheaper in price. According to Qualcomm they have the cost of digital overlay with the AMPS system. The cost of overlaying the CDMA is 1/3 the cost of overlaying GSM. One of the reasons is the fact that there aren't as many cell sites and base stations when deploying CDMA. This also makes the operating costs drop far below GSM. This is probably some companies have already started to overlay CDMA on their current AMPS systems.

The overlay of the digital cellular (IS-95) is not very complicated since the analog and digital services will not interfere with each other. IS-95 will be implemented and many cells will nave both IS-95 and AMPS. As time passes more and more users will convert to IS-95 and the cells with no analog users will be converted to a full digital system. At this point in time most cells have digital and analog

configurations. There is a concern to subscribers because digital coverage is not offered everywhere. To aid this problem the new mobiles have two modes, digital and analog, so subscribers can roam to any cell without the worry of not having compatibility with the base station.

In conclusion to the descriptions and comparisons it can be stated that IS-95 is going to be the leader in digital cellular services in the United States. IS-95 was the format that prevailed in the majority of the comparisons, and many cellular providers have already overlaid the technology in the AMPS system.

STUDY OF MATLAB®

MATLAB® is a very important and useful program on the computer. It is a fast way to write programs for presentations, and just as good when working with complicated math and or graphics. During my research I had a chance to learn how to use some of the many tools on MATLAB®. I learned how to write small programs and I completed some of my own scripts that compute sine waves and the Discrete Fourier Transform of the sine waves. In the programs I had to write smaller programs that did math computations when called upon. These programs were named "sincalc" and "dsfrtrns". Sincalc calculated the sin wave and dsfrtrns calculated the Discrete Fourier Transform of the sinewave.

Sincalc

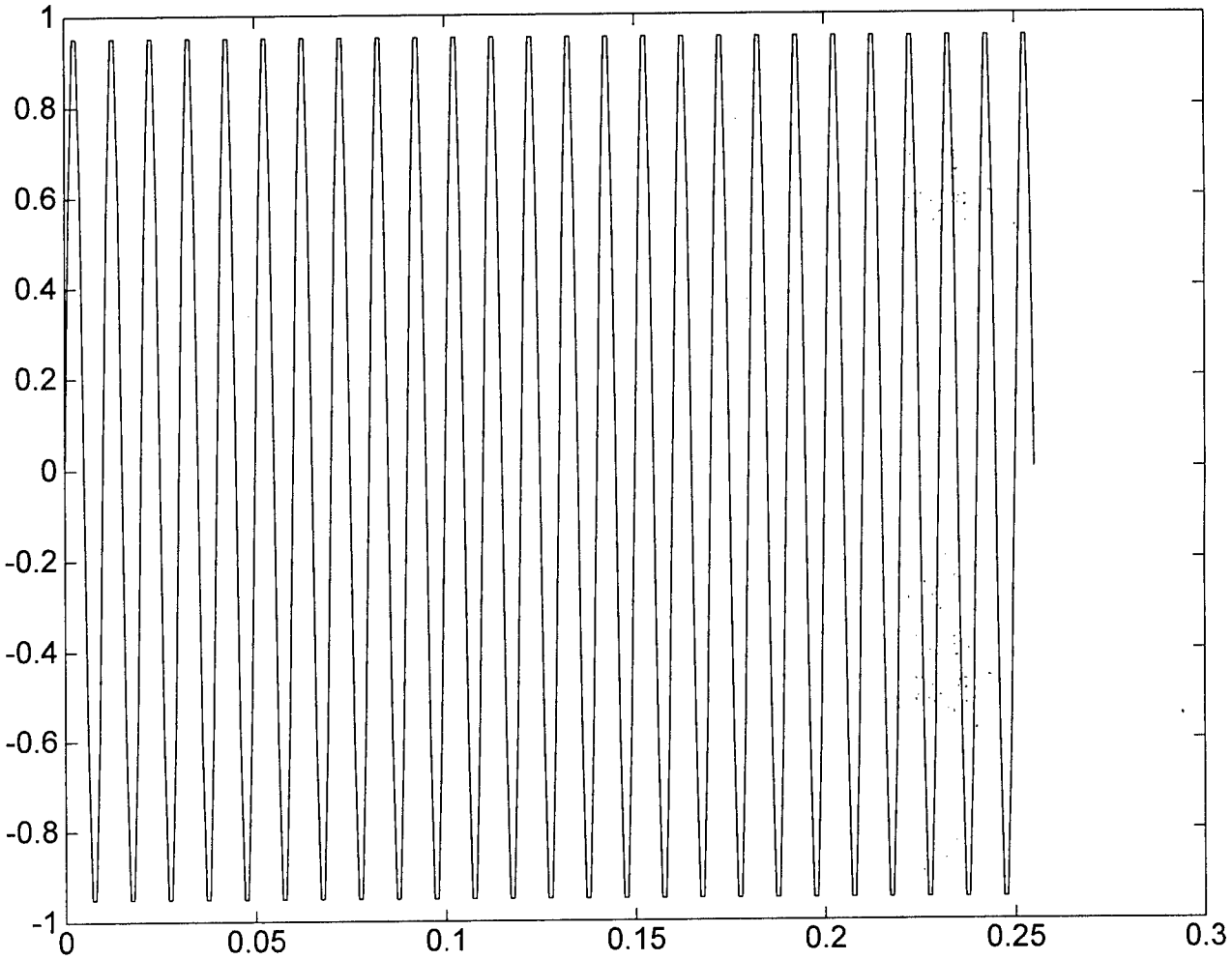
```
function waveform = sincalc(freq,time)
% function calcs sinwave
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
disp ('computing sinewave')
waveform = sin(2*pi*freq*time)  ;
```

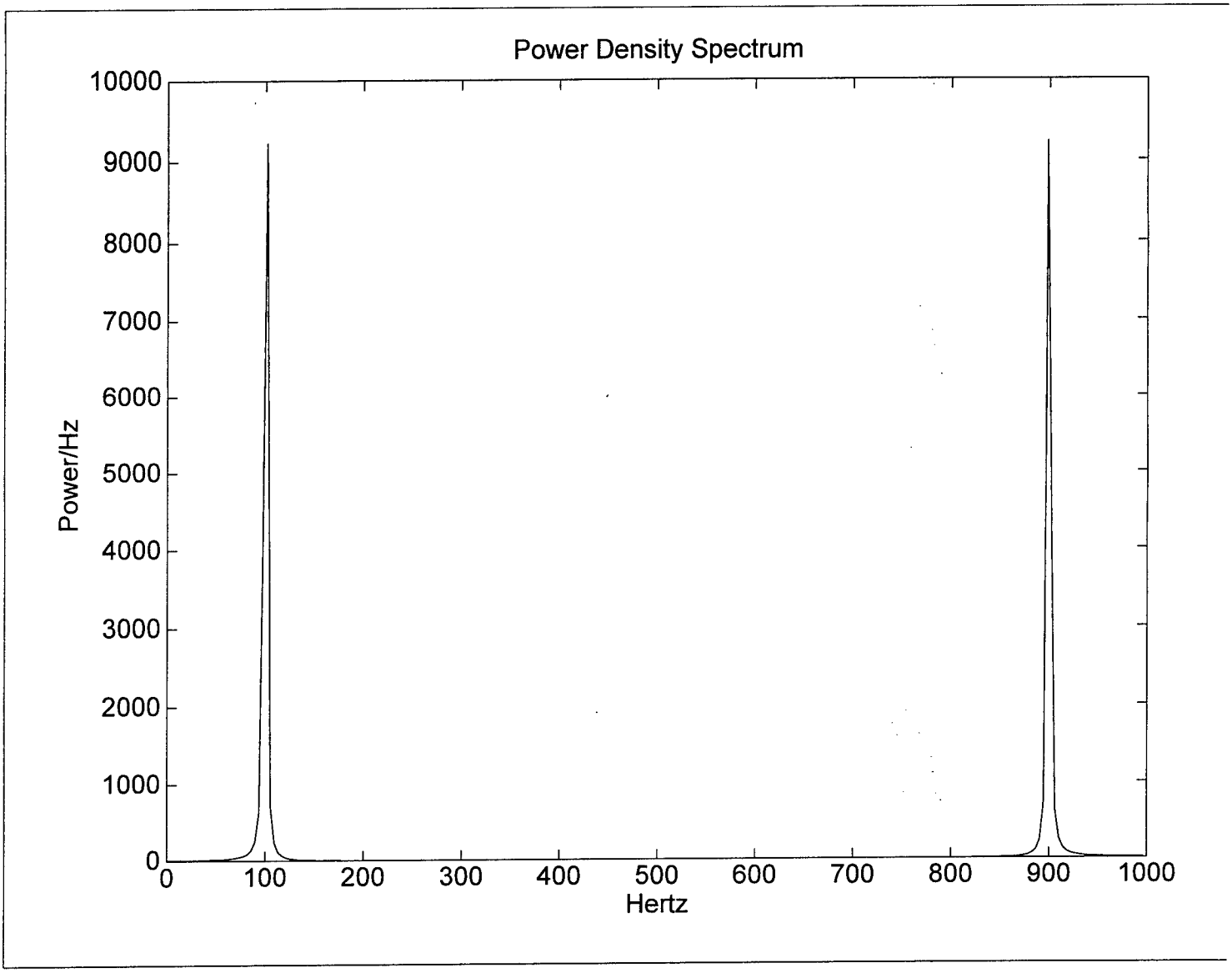
Dsfrtrns

```
function pspectrum =dsfrtrns(y,Nsamples)
% function performs Discrete fourier transform
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
disp ('performing Discrete fourier transform')
fvar = fft(y,Nsamples);
pspectrum = fvar.*conj(fvar) ;
%pspectrum = real(pspectrum)
disp ('houston we have a problem')
```

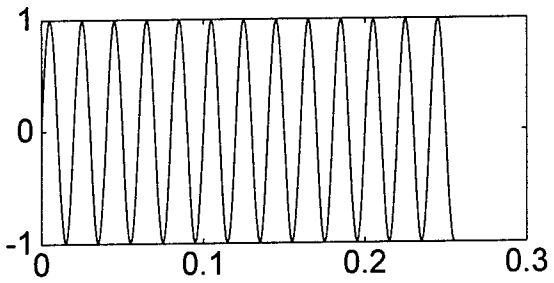
Two scripts that I wrote, followed by their graphs, are on the following pages. Both scripts run error free and produce sine wave and power density spectrum graphs. The first script calculates the sine wave and power density spectrum of one sample frequency. The second script calculates the sine wave and power density spectrum of three sample frequencies and applies them all to one graph.

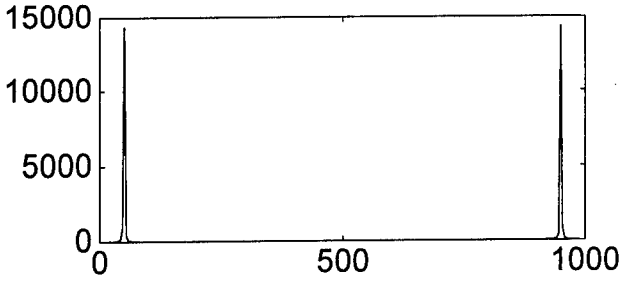
```
% freqgraph.m
% Michael Galime 7/8/98
% Nonsense, meaningless rubish
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% echo on
disp('hello uncle leo')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SETUP
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Fs = 1000;          % sample freq
dt = 1/Fs ;         % sample interval
Nsamples = 256;
Ttime = (Nsamples-1)*dt
t = 0:dt:Ttime;
size(t)
f =100
y = sincalc(f,t);
figure(1)
plot(t,y)
pause
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(2)
disp('computing fft')
Nfft = Nsamples
df = Fs/Nfft
Mfold = .5*Fs
%%%%%%%%%%%%%%%%%%%%%%%%%
pspectrum = dsfrtrns(y,Nsamples);
fvec = 0:df:Fs-df ;
plot(fvec,pspectrum) ;
title('Power Density Spectrum')
Xlabel('Hertz')
Ylabel('Power/Hz')
```

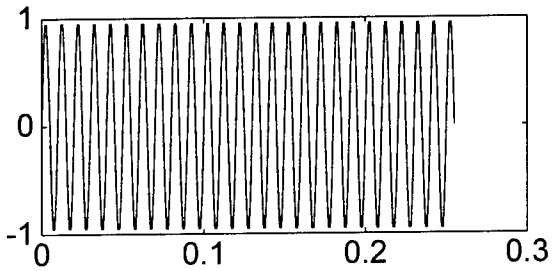

1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.05
0.1
0.15
0.2
0.25
0.3

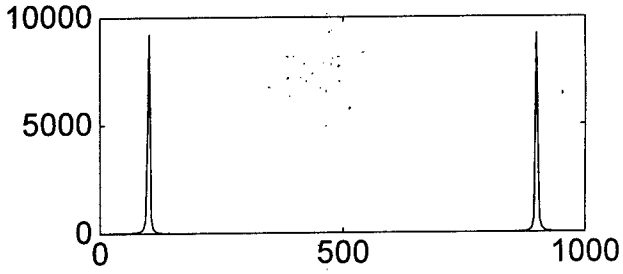

Power Density Spectrum
Power/Hz
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
100
200
300
400
500
600
700
800
900
1000
Hertz

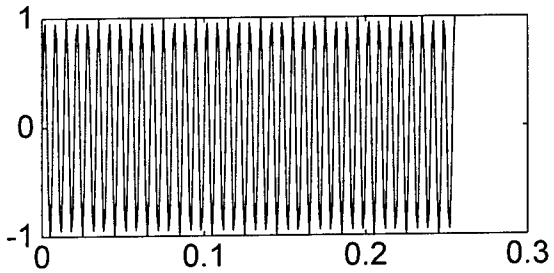
```
% freqgraphs.m
% Michael Galime 7/10/98
% Nonsense, meaningless rubish
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% echo on
disp('My name is bill and I am purple')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% SETUP
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Fs = 1000;           % sample freq
dt = 1/Fs ;          % sample interval
Nsamples = 256;
Ttime = (Nsamples-1)*dt
t = 0:dt:Ttime;
size(t)
fstart = 50
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
figure(1)
f = fstart
increment = 50
f = increment
for k = [1,3,5]
%%%%%%%%%%%%%%%%%%%%%%%%%
y = sincalc(f,t);
subplot(3,2,k)
plot(t,y)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
disp('computing fft')
Nfft = Nsamples
df = Fs/Nfft
Mfold = .5*Fs
pspectrum = dsfrtrns(y,Nsamples);
subplot(3,2,k+1)
fvec = 0:df:Fs-df ;
plot(fvec,pspectrum) ;
f = f + increment
end
disp('Mission Complete')
```

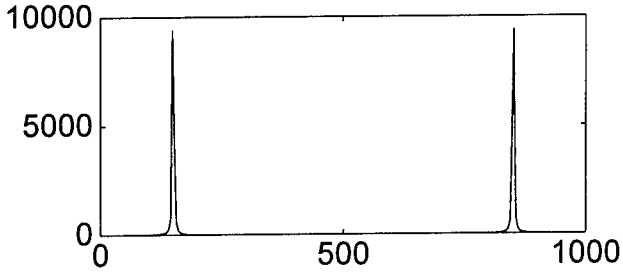

1
0
-1
0
0.1
0.2
0.3


15000
10000
5000
0
0
500
1000


1
0
-1
0
0.1
0.2
0.3


10000
5000
0
0
500
1000


1
0
-1
0
0.1
0.2
0.3


10000
5000
0
0
500
1000

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CAMPAIGN ASSESSMENT

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Rome Research Site

August 1998

Campaign Assessment

III. Colin M. Kinsella
Oneida High School

A. Abstract

The beginnings of this project were for me to learn how to do some modern programming in C++. The Microsoft Development Studio was the ideal solution to this by using the Microsoft Foundation Classes. The Microsoft Foundation Classes are Microsoft's own way of adding an easier way to write Windows programs without having to write your own reusable code for objects such as scroll bars. The semi-final product became a usable program across the Windows 95 platform with the look and feel of the Modern User Interface. What came out of this program was a great learning experience that will last a lifetime and greater influence on my motivation towards technology.

Campaign Assessment

Colin M. Kinsella

My summer project this year at Rome Research was on writing the graphical user interface for a defense program to determine campaign assessment. This was done using Microsoft Visual C++ version five, using MFC's, Microsoft Foundation Classes.

My mentor Dr. John F. Lemmer decided at the beginning of this project to use the Microsoft Foundation Classes for the development of this program. The MFC's really take a long time to get use to, and with the help of the great Microsoft documentation that leads you around in circles, it took a little bit longer to get my feet on dry land. The MFC's really made life easier when their mysteries were finally understood. It provided a lot of functionality that made the scroll bar logic, serialization, and a few other things a thousand times easier.

This whole project dealt with the problem of campaign assessment in the Air Force. It is a historical fact that in World War II Hitler thought he was winning the air campaign against Britain until he find out that he did not have enough planes to finish his mission. The technology that is hidden behind this user friendly interface is one of Bayesian Networks. It is an artificial intelligence technology that is used to determine events through probabilities, outcomes, etc. which all help in the planning of a war. I am still not very familiar with all of that technology, but that part is left up to Dr. John Lemmer, Rockwell, and anyone else who is working on the artificial intelligence portion of the program.

This summer was mostly a learning experience for both John and I. Neither of us have ever used the Microsoft Foundation Classes, and took us awhile to understand it. But after the fact I would not think twice of using MFC's to develop a program. It is very powerful with all of the little add-ons you can put in your program quick and easily that make life easier for the user.

Some of the modern user interface features that we added in our program were docking windows, tree views, tooltips, common color and file dialogs, along with some other exotic features. Each one of these features usually took a few days to get the feel for, but after made a lot of functionality to the program. For example, the common file dialog box made life a thousand times easier. All it took was a few statements to select the filter options of which files you want it to select, along with some serialization code and voila done. A lot of the programming took place in the code for drawing the connections between the object boxes. Calculations were needed to figure out the right point just outside of the box, and then determine the opposite point of the adjoining box. Then from there the signal connection between the two boxes was drawn with logic to rotate the connector as the boxes were moved around each other. Here is some of the code for the drawing portion of the connections between the process objects:

```
void CCampaignAssessmentView::DrawOneConnection(CProcessObject * Process1,
        CProcessObject * Process2, BOOL bErasing)
{
        // Creation and deletion of pens and selection of the pens decided by
        // the fact of the window being moved or not, along with the creation
        // and deletion of a device context

        CPen hBlackPen, hWhitePen, hWideWhitePen;
        hWhitePen.CreatePen(PS_SOLID, 1, RGB( 255, 255, 255 ));
        hBlackPen.CreatePen(PS_SOLID, 1, RGB( 0, 0, 0 ));
        CDC* hDC = GetDC();
        CPen* hOldPen = hDC->SelectObject( &hBlackPen );

        CRgn* Plug = new CRgn();

        // Selection of pens depending on if signals need to be drawn or erased
        if( bErasing )
        {
                hDC->SelectObject( hWhitePen );
        }
        else
        {
                hDC->SelectObject( hBlackPen );
        }

        // Declaring and initiating values
        CPoint BeginCenter, EndCenter, MidCenter, OuterRgnBegin, OuterRgnEnd;
```

```
// Get Placement of the Process in relation to the screen and other process
WINDOWPLACEMENT lpwndpl;
Process1->GetWindowPlacement(&lpwndpl);
m_rBeginLoc = lpwndpl.rcNormalPosition;
Process2->GetWindowPlacement(&lpwndpl);
m_rEndLoc = lpwndpl.rcNormalPosition;

// Setting values for the centers of the two Process connected together
// and finding the mid-point between them
BeginCenter.x = (m_rBeginLoc.right - m_rBeginLoc.left) / 2 + m_rBeginLoc.left;
BeginCenter.y  = (m_rBeginLoc.bottom - m_rBeginLoc.top) / 2 +
        m_rBeginLoc.top;
EndCenter.x = (m_rEndLoc.right - m_rEndLoc.left) / 2 + m_rEndLoc.left;
EndCenter.y = (m_rEndLoc.bottom - m_rEndLoc.top) / 2 + m_rEndLoc.top;
MidCenter.x = (EndCenter.x - BeginCenter.x) / 2 + BeginCenter.x;
MidCenter.y = (EndCenter.y - BeginCenter.y) / 2 + BeginCenter.y;

// Initializing the sizes of the Ellipse and Arc created
int ArcSize = 20;
int HalfArcSize = ArcSize / 2;
int EllipseSize = 10;
int HalfEllipseSize = EllipseSize / 2;

// Calculations of the Ellipse and Arc drawn to align them
// in the proper position of the signal
int xLeftEllipse = MidCenter.x - HalfEllipseSize;
int yTopEllipse = MidCenter.y - HalfEllipseSize;
int xRightEllipse = MidCenter.x + HalfEllipseSize;
int yBottomEllipse = MidCenter.y + HalfEllipseSize;

int xLeftArc = MidCenter.x - HalfArcSize;
int yTopArc = MidCenter.y - HalfArcSize;
int xRightArc = MidCenter.x + HalfArcSize;
int yBottomArc = MidCenter.y + HalfArcSize;

// Define the arc rectangle for the tooltips function
m_rArc.left = xLeftArc;
m_rArc.top = yTopArc;
m_rArc.right = xRightArc;
m_rArc.bottom = yBottomArc;

// Finding the slope and perpendicular slope of the line
// produced by connecting two process
float dy = (float) (EndCenter.y - BeginCenter.y);
float dx = (float) (EndCenter.x - BeginCenter.x);
float slope = dy / dx;
float PerpendicularSlope = -(1/slope);

// Calculating the absolute value of the slope
float abslope = OurABS(slope);

// Alignment of the arc to follow the line created by
// the two processes
int bx, by;
```

```
if( PerpendicularSlope <= 1 && PerpendicularSlope >= -1 )
{
        bx = HalfArcSize;
        by = int((PerpendicularSlope * HalfArcSize) + .5);
}

else
{
        bx = int((1 / PerpendicularSlope) * HalfArcSize + .5);
        by = HalfArcSize;
}

// Calculating the starting and end points of where to start
// and finish the drawing of the arc
int xStart = MidCenter.x + bx;
int yStart = MidCenter.y + by;
int xEnd = MidCenter.x  - bx;
int yEnd = MidCenter.y - by;

// The following section is designed to draw from a point just on the
// outside of one process to a point just on the outside on another
// process for a better repaint job on the motion

// Calculations for the first process

// Calculate the point when on the right side of the first process
if( (abslope <= 1) && (dx > 0) )
{
        OuterRgnBegin.x = m_rBeginLoc.right;
        OuterRgnBegin.y = (long) (-slope * (BeginCenter.x - (m_rBeginLoc.right
                + 1)) + BeginCenter.y);
}

// Calculate the point when on the top side of the first process
else if( (abslope >= 1) && (dy < 0) )
{
        OuterRgnBegin.x = (long) (BeginCenter.x - (BeginCenter.y -
                (m_rBeginLoc.top - 1)) / slope);
        OuterRgnBegin.y = m_rBeginLoc.top - 1;
}

// Calculate the point when on the left side of the first process
else if( (abslope <= 1) && (dx < 0) )
{
        OuterRgnBegin.x = m_rBeginLoc.left - 1;
        OuterRgnBegin.y = (long) (-slope * (BeginCenter.x - (m_rBeginLoc.left -
                1)) + BeginCenter.y);
}

// Calculate the point when on the bottom side of the first process
else if( (abslope >= 1) && (dy > 0) )
{
```

```
        OuterRgnBegin.x = (long) (BeginCenter.x - (BeginCenter.y -
                (m_rBeginLoc.bottom + 1)) / slope);
        OuterRgnBegin.y = m_rBeginLoc.bottom;
}

// Calculations for the second process

// Calculate the point when on the right side of the first process
if( (abslope <= 1) && (dx > 0) )
{
        OuterRgnEnd.x = m_rEndLoc.left;
        OuterRgnEnd.y = (long) (-slope * (EndCenter.x - (m_rEndLoc.left - 1)) +
                EndCenter.y);
}

// Calculate the point when on the top side of the first process
else if( (abslope >= 1) && (dy < 0) )
{
        OuterRgnEnd.x = (long) (EndCenter.x - (EndCenter.y -
                (m_rEndLoc.bottom + 1)) / slope);
        OuterRgnEnd.y = m_rEndLoc.bottom - 1;
}

// Calculate the point when on the left side of the first process
else if( (abslope <= 1) && (dx < 0) )
{
        OuterRgnEnd.x = m_rEndLoc.right - 1;
        OuterRgnEnd.y = (long) (-slope * (EndCenter.x - (m_rEndLoc.right + 1))
                + EndCenter.y);
}

// Calculate the point when on the bottom side of the first process
else if( (abslope >= 1) && (dy > 0) )
{
        OuterRgnEnd.x = (long) (EndCenter.x - (EndCenter.y - (m_rEndLoc.top -
                1)) / slope);
        OuterRgnEnd.y = m_rEndLoc.top;
}

// Moving to the starting point of where the connection is
// to be drawn between two processes
hDC->MoveTo( OuterRgnBegin.x, OuterRgnBegin.y );
hDC->MoveTo( MidCenter.x, MidCenter.y );
hDC->LineTo( OuterRgnEnd.x, OuterRgnEnd.y );

hDC->SelectObject( hWhitePen );
hDC->Ellipse( xLeftArc, yTopArc, xRightArc, yBottomArc );

// Used to determine the correct pen depending on the drawing or
// erasing of a signal
if( bErasing )
{
        hDC->SelectObject( hWhitePen );
}
```

```
        else
        {
                hDC->SelectObject( hBlackPen );
        }

        hDC->MoveTo( OuterRgnBegin.x, OuterRgnBegin.y );
        hDC->LineTo( MidCenter.x, MidCenter.y );

        // Creation of the Center Ellipse or Plug
        // Filled with a black brush
        Plug->CreateEllipticRgn( xLeftEllipse, yTopEllipse, xRightEllipse, yBottomEllipse
                );
        hDC->SelectObject( (HBRUSH) GetStockObject(BLACK_BRUSH) );
        hDC->PaintRgn( Plug );

        // Logic for the correct rotation of the signal when moving processes
        // around each other
        if ( ((abslope >= 1) && (dy < 0) )
          || ((abslope <= 1) && (dx > 0) ) )
        {
                hDC->Arc( xLeftArc, yTopArc, xRightArc, yBottomArc,
                        xStart, yStart, xEnd, yEnd );
        }

        else
        {
                hDC->Arc( xLeftArc, yTopArc, xRightArc, yBottomArc,
                xEnd, yEnd, xStart, yStart );
        }

        // Clean up, selection of the old pen and deletion of pens
        // not needed anymore for the freeing of the device context
        hDC->SelectObject( hOldPen );
        ReleaseDC( hDC );
        hBlackPen.DeleteObject();
        hWhitePen.DeleteObject();
        Plug->DeleteObject();
}
```

As you can see there is a lot of code for a very small visual effect of moving lines between two objects. Stepping through the code line by line would make this paper ten-fold longer delving into all of the mysteries of windows. Even though this is a pretty small segment of code it deals with the windows paint message. Windows has messages going behind its nice graphical user interface that the common user never knows about. If you, the reader is interested in some of the aspects of windows programming, a great book to get is

"Programming Windows 95" by Charles Petzold and Paul Yao. This book teaches a lot of basics and with a little motivation the rest is a piece of cake.

In conclusion, I would like to thank everyone at Rome Laboratory. Especially Dr. John Lemmer my mentor, the secretaries, and all the hierarchy that made my trip possible to Palo Alto. I would also like to thank everyone at RDL for their cooperation with the trip, since from my knowledge have never encountered this problem before. Thanks again everyone, it was a great summer filled with memories and experience to last a lifetime.

RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES AND THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

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Final Report for:
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Sponsored by:
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I would like to thank everyone at the Air Force Research Laboratory at the Rome Research Site (AFRL/RRS) for making my summer one to remember. Especially,

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RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES FOR WEB PAGES AND THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

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Abstract - RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES

HyperText Markup Language (HTML) is a computer language used to make web pages that is written in a text format, but is graphically shown on the Internet. The appearance of the web pages directly relates to the tags you use. Tags can create different text, colors, images, tables, forms, links, and applets. The structure of an HTML file consists of a head and body.

Abstract - RESEARCH INVESTIGATIONS OF THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

SynTactic Analysis using Reversible Transformations (START) is a natural language processing system. This system originated in 1980 by Prof. Boris Katz at Massachusetts Institute of Technology. (MIT; Katz, Boris; www.ai.mit.edu /people/boris/webaccess/node1.html#00010000000000000000) START was put on the worldwide web in 1993. The user can receive information by entering a query in English. The program takes the query, creates T-expressions from the query, and uses these T-expressions to find information in its knowledge base.

RESEARCH INVESTIGATIONS OF HYPERTEXT MARKUP LANGUAGE (HTML) FOR WEB PAGES

Peter M. LaMonica

INTRODUCTION

HyperText Markup Language (HTML) is a computer publishing language used for the creation of web pages. HTML is a hypertext variant of Standard Generalized Markup Language (SGML) which marks up document parts so the browser knows what these parts are. HTML is used in the creation of worldwide web pages. Using HTML, the web page creator can specify what parts of the text are to be a table, frame, heading, list, and which parts are to be bold, italicized, and so on. All of this is done through tags the creator places into the HTML file. HTML files are always plain text.

PROBLEM

The Air Force Research Lab /Rome Research Site (AFRL/RRS) set of web pages needed to be updated and new web pages needed to be created using new versions of HTML.

METHODOLOGY

I needed to learn the HTML language, so I went to the library and took out three books on HTML. I created my own web pages for practice as I went through these books, picking up new concepts. I learned about tags and how they interface to the browser regarding the type of text that will be produced. All tags have the greater than (<) and less than (>) signs around them and most tags need a closing tag (Ex. text). Other tags, called empty tags, do not need a closing tag (Ex.
). Some important tags are: <html> to start a document, </html> to end a document; <head>, </head>; <title>, </title>; <body>, <body> which you write all text. Other tags are <a href> to link a web page; <img> to put an image in; <bgcolor> to set the background color; <text> to set the text color; <font> to set the font; <frameset> to set how many frames you want; and <frame> to set what you want in the frame.

The editing required for the web pages required changes to the text and background color, change images, add templates, edit E-Mail addresses, and updates to the fellow creator's name. Several pages that helped complete the updating process were accomplished.

RESULTS

All of the web pages look similar and professional with added style. The new web pages provide the user with new knowledge. As a result, several new web pages were created and are now being used successfully by AFRL/RRS scientists.

CONCLUSION

HTML is a scripting language where everything is written in English on a word processing program that is projected graphically through the Internet. HTML allows not only the creation of web pages, but is one of the easiest ways to access information from anywhere in the world. HTML revolves around tags the creator uses in order to make the web page and ways to improve its style. Using HTML, I was able to create a useful series of factual web pages easily.

The following pages are example of HTML code and actual web page that I created during my apprenticeship.

```html
<html>

<title>Dynamic Data Mining Using an Electro-Optical Data Warehouse </title>

<BODY BGCOLOR = "#003366" LINK ="#00FFFFF" ALINK = WHITE VLINK = GOLD>

<FONT = 3 COLOR = white>

<Font size= 5 color=gold><I><STRONG><CENTER>Dynamic Data Mining Using an
Electro-Optical Data Warehouse</CENTER></I></STRONG></font size>

<BR><BR><BR>

Ultra large user oriented distributed multimedia information systems that
manage terabytes of data must provide rich functionality so that interesting
new applications can be addressed. Since a wealth of data, information and
knowledge are resident within these vast repositories, a variety of data mining
techniques have developed. These techniques are very computionally
intensive and require the movement of large amounts of data. In the search
for new approaches, optics may be able to help since photons have the very
attractive properties of high speed, non-interference, and parallelism. Optical
systems can accommodate a large number of parallel, high-bandwidth
channels and optical storage devices have very high storage densities.

<BR><BR>

In this purposed program we will postualte an electro-optical computer
achitecture and examine the feasibility of executing a number of data mining
and knowledge discovery algorithms on ultra large multimedia
data/knowledge bases with the express purpose of increasing performance
and functionality. Electro-optical special purpose architecture enhancements
and advanced adaptable memory design/configurations will be investigated in
order to postulate an innovative electro-optical computer architecture. In
addition, the feasibility of interfacing with intelligent agents on the web and
with mobile hand held computing devices will be investigated.

<BR><BR>

</smaller></color>
<IMG src="goldbar.gif" broder=0 height=2% width=98%>
<img align = right src = "sm.gif">
<font color = white>
<address>this web page was created by
<font color = gold>
 Peter LaMonica
</address>

<!----------*********************************************----------->
<!------------------ End of the playing field.--------------------->
```

```
<BR><BR>

<P><FONT SIZE=2 COLOR=BLUE>
<I>Last Updated:
<!---------Enter last date of page modification here---------->
<!----------**********************************************----------->
4 August 1998
<!----------**********************************************----------->

<BR>

<!--Enter the web page creator's email address after the ":" below-->
<!----------**********************************************----------->
<A HREF="mailto:">pagemaster email</A><BR>
<!----------**********************************************----------->

<!----Enter the page's technical point of contact email address --->
<!----------------------after the ":" below---------------------->
<!----------**********************************************----------->
<A HREF="mailto:">Technical POC email</A>
<!----------**********************************************----------->
</I>
</FONT>
</P>

</body>

</html>
```

Dynamic Data Mining Using an Electro-Optical Data Warehouse

Ultra large user oriented distributed multimedia information systems that manage terabytes of data must provide rich functionality so that interesting new applications can be addressed. Since a wealth of data, information and knowledge are resident within these vast repositories, a variety of data mining techniques have developed. These techniques are very computionally intensive and require the movement of large amounts of data. In the search for new approaches, optics may be able to help since photons have the very attractive properties of high speed, non-interference, and parallelism. Optical systems can accommodate a large number of parallel, high-bandwidth channels and optical storage devices have very high storage densities.

In this purposed program we will postualte an electro-optical computer achitecture and examine the feasibility of executing a number of data mining and knowledge discovery algorithms on ultra large multimedia data/knowledge bases with the express purpose of increasing performance and functionality. Electro-optical special purpose architecture enhancements and advanced adaptable memory design/configurations will be investigated in order to postulate an innovative electro-optical computer architecture. In addition, the feasibility of interfacing with intelligent agents on the web and with mobile hand held computing devices will be investigated.

this web page was created by Peter LaMonica

Last Updated: 4 August 1998
pagemaster email
Technical POC email

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RESEARCH INVESTIGATIONS OF THE START NATURAL LANGUAGE KNOWLEDGE BASE SYSTEM

Peter M. LaMonica

INTRODUCTION

SynTactic Analysis using Reversible Transformations (START) is a natural language system that consists of two modules that share the same grammar. This system was developed by Professor Boris Katz at Massachusetts Institute of Technology (1980). The user enters an English query to retrieve information from START. START is a tool used in the area of High Performance Knowledge Bases (HPKB) that can be used when quick accessed, accurate information is wanted. START is the result of research at MIT and other universities and laboratories for developing and querying knowledge bases using English text.

PROBLEM

The Air Force Research Lab /Rome Research Site (AFRL/RRS) had required detailed investigations of START to both analyze and evaluate its capabilities.

METHODOLOGY

I needed to understand how START worked so I went to Prof. Katz's MIT web pages for information about this system. The user enters an English query that he/she wants information about. START takes the query and divides it into T-expressions. A main T-expression consists of <subject relation object>. An example would be the query *"What is the climate in China?"* START makes two T-expressions of this. The first is <What is the climate>. Additional T-expressions depend upon adjectives, possessive nouns, prepositional phrases, etc... In this example the additional T-expression would be <in China>. START then takes these T-expressions to search its knowledge base for any T-expressions which contain information that is relevant to providing an answer to the question. START's process can be found on page 7-13. Once I learned how START worked, I began to analyze this system. I analyzed it by entering 120 queries where 60 of these queries to its knowledge base had the

correct answers and 60 of the queries had no such correct answers. START can answer questions about weather, militaries, a country's culture, locations, directions, governments, etc...

Next I interfaced directly via E-mail with Prof. Katz at MIT to see if it would be possible for START to respond to queries regarding the (AFRL/RRS) web page. He replied and explained that it would be possible. After a series of interactions with Prof. Katz. it is now posiible for START to intelligently process data at the AFRL/RRS web page.

RESULTS

Pages 7-14 to 7-15 I described and gave examples of the types of questions I asked START and what type of response I received. As a result, scientists at AFRL understand how START works, what its process is, and its capabilities. Prof. Katz cooperated regarding these questions on START:

-Where is Rome Laboratories?
-Show me the Rome Labs homepage.
-How far is it from Rome NY to Boston?*
-What cities are within 150 miles of Rome Labs?*
-How do I drive from Rome Labs to Boston?*
-Show me the map of Rome Labs.
-Give me directions from Hancock International Airport to Rome Labs.
-Show me the IFTB web page.
-What does IFTB do?

*-the cities or miles can be interchanged

These questions make easy access for people who want basic information about AFRL/RRS capabilites.

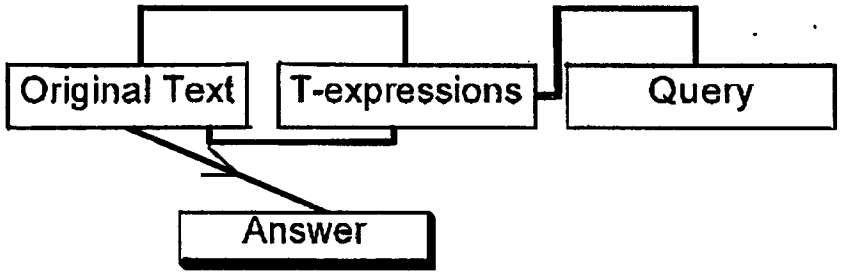
CONCLUSION

START is a natural language knowledge base system that allows its user to enter an English query to retrieve its wanted information. START is an

excellent system to have when you want fast, accurate information. Especially, it would help the military planning an attack to find out information at that location. It does have more developing to go through in answering queries with knowledge that it has instead of stating it doesn't know.

START's Process

www.ai.mit.edu/project/infolab/hpkb/hpkb.html



Main T-expressions = <subject relation object>
Ex: What is the weather in Milan? T-expressions=<<What is the weather>in Milan>

START ANALYSIS

BY:PETE LAMONICA

http://www.ai.mit.edu/projects/infolab/hpkb/hpkb.html

	ANSWER WAS TRUE	***ANSWER WAS FALSE***
WHEN I RECEIVED NO ANSWER	**13.9%**	**35.7%**
WHEN I RECEIVED AN ANSWER	**37.4%**	**13.0%**

****ANALYSIS WAS BASED ON 120 RANDOM QUESTIONS***

Pete LaMonica
START Analysis

When I Received No Answer and the Answer Was True:
When this happened the database had no knowledge of the answer that I was seeking. An example of this would be the question, "What cities does Iraq have military bases in?" The database didn't know this. It replied saying, "Sorry, I don't know the answer to your question." START was telling the truth because it didn't know. I know this because I went to its source for its answers, The 1997 World Factbook. Therefore, I placed it in this category. Another example of this would be the question, "What's the population of Baghdad, Iraq?" It replied, "Sorry, I don't know." Again I went to its source and I didn't find it.

When I Received No Answer and the Answer Was False:
When this happened the database had this knowledge, but instead of telling the answer, it replied it didn't know. For example, the question, "When did Canada receive its independence?" It replied, "I don't know the answer to this question." Again I went to the source and I found the answer. *Independence: 1 July 1867 (from UK).* Another question was "What are the elevation extremes in Canada?" It replied, "I don't have this information." But, there it was clearly stating the elevation extremes in the source. *Elevation extremes: lowest point: Atlantic Ocean 0 m; highest point: Mount Logan 5,950 m.* So, there are the answers to my questions copied directly from the factbook. Throughout this I tried several different ways to rephrase the questions but had no luck receiving any answers.

When I Received An Answer and the Answer Was True:
When this happened the database had the knowledge and it gave me the correct exact answer. For example, "What's the climate in Kuwait?" It replied giving me the flag of Kuwait (which it does for any answer given for that specific country), the information I requested for the climate, and the link to the source for this specific information. Another example, "What countries

border the Persian Gulf?" It replied with a list of these countries, a map of the Persian Gulf, and the source for the answer.

When I Received An Answer and the Answer Was False:
When this happened the database would give me an answer but, the answer was false. One question I asked was, "Who is the President of Iraq?" In return, I got the whole executive branch of Iraq. Therefore since I asked simply who the President was, and it gives me the whole executive branch I placed it in this category. Another example is the question, "Does Kuwait have an Air Force?" I received all of the military branches of Kuwait, its military manpower availability, and the military expenditures. Another time I asked, "Who is the chief of state in Canada?" In return, I received a link to a movie webpage.

My Thought:
I think START can be a huge asset for a wide variety of queries. The problems that I uncovered during my research investigation from START are:

- Doesn't understand all English queries all the time
- Gives correct answer but with additional unwanted information
- Doesn't answer some questions even though the answer is available

The positive aspect of START is its ability to take an English language query and quite rapidly give an accurate response by interfacing to many of its knowledge sources and web knowledge tools. START will be a very valuable addition to the growing list of intelligent knowledge base tools.

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Katz, Boris; START Natural Language Processing System; http://www.ai.mit.edu/people/boris/webaccess/node4.html#section00040000000000000000

NEW METRICS FOR MEASURING SEMANTIC RELATEDNESS USING ROGET'S THESAURUS

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Final Report for:
High School Summer Apprenticeship Program
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Rome, NY

August 1998

NEW METRICS FOR MEASURING SEMANTIC RELATEDNESS USING ROGET'S THESAURUS

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Ithaca College

Abstract

New metrics to measure the semantic relatedness of word pairs were tested using Roget's International Thesaurus, Third Edition. The hierarchy of Roget's was turned upside down, and this new view of the hierarchy lent itself well to the new metrics. The large surprise, though was the True / False metric. It gave a one to words who shared a category. This metric performed better than expected because of the nature of the list of word pairs. The first fourteen word pairs were given high marks as to their relatedness; the last fourteen were given low marks. Accordingly, more testing needs to be done with more word pairs.

NEW METRICS FOR MEASURING SEMANTIC RELATEDNESS USING ROGET'S THESAURUS

Christopher Lipe

Introduction

The field of semantic relatedness concentrates on determining how closely related two words are. Getting computers to be able to determine how similar two words are relates to natural language processing in the field of artificial intelligence. It can be of use in language searches, filtering, and comprehension.

The two main sources used for measuring semantic relatedness are WordNet, and Roget's Thesaurus. WordNet (Miller 1990) is a large resource of related words that was designed to be used by computers, and is therefore the most popular resource for the study of semantic relatedness. Roget's Thesaurus dates back to 1852, when Peter Roget first compiled his taxonomy of words. The edition of Roget's Thesaurus used in the research in this paper is Roget's International Thesaurus, Third Edition (Roget 1962).

There are many different methods, or metrics, for measuring how related two words are. In the field of semantic relatedness, there is a set of twenty-eight word pairs which have been rated by humans on a scale of 0 to 4, 0 indicating no synonymy, and 4 indicating perfect synonymy. (Miller and Charles 1991) What researchers do is devise a specific method of putting values on relatedness using the words in one of the two aforementioned sources. These values are then correlated with the human values to test their accuracy.

Table 1 - Human values for standard word pairs

Word Pair	Value	Word Pair	Value	Word Pair	Value
car-automobile	3.92	bird-cock	3.05	coast-hill	0.87
gem-jewel	3.84	bird-crane	2.97	forest-graveyard	0.84
journey-voyage	3.84	tool-implement	2.95	monk-slave	0.55
boy-lad	3.76	brother-monk	2.82	coast-forest	0.42
coast-shore	3.70	crane-implement	1.68	lad-wizard	0.42
asylum-madhouse	3.61	lad-brother	1.66	chord-smile	0.13
magician-wizard	3.50	journey-car	1.16	glass-magician	0.11
midday-noon	3.42	monk-oracle	1.10	noon-string	0.08
furnace-stove	3.11	food-rooster	0.89	rooster-voyage	0.08
food-fruit	3.08				

Types of Metrics

Most of the metrics used to determine relatedness given the groupings of words in either WordNet or Roget's Thesaurus can be divided into two groups: distance based metrics, and information based metrics. They differ in their approach to measuring relatedness. The simplest, and one of the most effective, distance based metrics is called edge counting. It takes a hierarchy and literally measures the distance from one word to another first going up the hierarchy to a common ancestor, and then back down to the target word. This has been the best metric found when used with Roget's Thesaurus, with a correlation of .8862. (Mc Hale 1998) Another distance-based metric is found by counting the straight-line distance between two words, disregarding the hierarchy. This method of measuring relatedness by intervening words between two words does not work too well, however. (Mc Hale 1995)

Information based similarity measures relatedness based on the probability of encountering a concept. More common words have lower information contents. The information contents of nodes inside the hierarchy are based on the information contents of the nodes and words below them. (Resnik 1995)

Turning the hierarchy upside down

The words in Roget's Thesaurus are arranged in a taxonomic hierarchy. At the top of the hierarchy are broad concepts, and these branch out into smaller and smaller groups, until individual words can be found at the bottom. However, It is also possible to turn the hierarchy upside down, and consider each word as the focus of its own hierarchy. This concept can be represented as a pyramid in levels. At the top level is the word itself. The second level contains all the words in the same semicolon group as the word. At each level below that, the category encompassed gets broader and broader, until at the base are all the words of the thesaurus. Comparing the pyramid with its equivalent in the hierarchy, the apex of the pyramid is one word at the bottom of the hierarchy. The next level consists of all the words whose nearest common ancestor to the apex word is one node up the hierarchy. The third level has all the words whose common ancestor is two nodes up, and so on, until the base of the pyramid is equivalent to all the words whose common ancestor is the apex of the hierarchy. If a word has more than one entry in Roget's, its pyramid contains words related to all the entries; i.e. in level 2 are the words from each semicolon group the root word is found in, and so on. This forms a word pyramid rather than an inverted hierarchy of words because, for example, level 3 is not descended from level 2 on the pyramid, as it would in a hierarchy, in fact, level 2 is a subset of level 3. This way of considering the hierarchy "upside down" lends itself to considering metrics which would be awkward at the very least in a traditional hierarchy.

One idea that came naturally from this pyramid view of the hierarchy was an attempt to measure the information content of a word based on the number of words under it in the pyramid. If a word had many closely related friends, then the idea it portrayed would be more common and therefore contain less information. Therefore, IC(a) = 199274 / (Words under "a"), where 199274 is the number if words in the total hierarchy. This defines Information Content as the ratio of words in the total hierarchy to the number of words under the concept. The similarity of two concepts could be expressed as:

IC (a) + IC (b) / IC (a and b).

This equation was tested because a word pair which had many words in common below them would be more related, and this equation shows that[1]. A word which had many diverse meanings would have a small Information Content, and therefore not be able to have a strong relation with any word, just as a weak magnet cannot have a large attraction to any magnet, even if it is a polar opposite.

However, as it turns out, this equation does not work because its value is based on not only the number of words each idea has in common, but also how close the total number of words under A was to the total number of words under B, regardless of what words they were.

IC (a) = 199274/W(a)

IC (b) = 199274/W(b)

IC (ab) = 199274/W(ab)[2]

$$IC(a) + IC(b) / IC(ab) = \frac{\frac{199274}{W(a)} + \frac{199274}{W(b)}}{\frac{199274}{W(ab)}}$$

$$\frac{\frac{199274}{W(a)} + \frac{199274}{W(b)}}{\frac{199274}{W(ab)}}$$

199274 cancels from each expression, leaving:

[1] For this equation, a smaller number indicates a greater relatedness. Some of the metrics shown in this paper give larger values for relatedness, some smaller. The ones that give smaller values for greater relatedness produce correlations that are negative. All correlations in this paper are therefore absolute values.

[2] W(a and b) = W(a) + W(b) – W(common)

$$\frac{\frac{1}{W(a)}}{\frac{1}{W(ab)}} + \frac{\frac{1}{W(b)}}{\frac{1}{W(ab)}}$$

$$\frac{W(ab)}{W(a)} + \frac{W(ab)}{W(b)}$$

$$\frac{W(ab)W(b)}{W(a)W(b)} + \frac{W(ab)W(a)}{W(a)W(b)}$$

Which simplifies to:

$$\frac{W(ab)\,(W(a) + W(b))}{W(a)W(b)}$$

Which, when W(ab) = W(a) + W (b) (i.e., the word pair has no words in common), simplifies to:

$$\frac{(W(a) + W(b))^2}{W(a)W(b)}$$

The ratio

$$\frac{(W(a) + W(b))^2}{W(a)W(b)}$$

behaves thusly:

$$\lim_{W(a) \to W(b)} \frac{(W(a) + W(b))^2}{W(a)W(b)} = \frac{(2\,W(b))^2}{W(b)^2} = 4$$

$$\lim_{W(a) \to 0} \frac{W(a) + W(b)}{W(a)W(b)} = \infty$$

So, the closer W(a) and W(b) are, the value of this metric approaches 4, while the farther apart W(a) and W(b) are, the greater the value of the metric. Even if W(ab) ≠ 0, the metric tends to be greater the more W(a) ≠ W(b). So, being based on both relatedness and number of terms in each word's pyramid, this metric does not work for determining relatedness alone. The correlations for this metric were very poor, peaking at .49 at the category level.

Word Counting

One metric that seemed to solve the problems of the previous metric while still preserving the essential idea behind it was the Word Counting metric.

$$\frac{W(a) + W(b) - W(ab)}{W(ab)}$$

This metric gives better ratings to word pairs which have a lot of words in common between corresponding levels on their pyramids. A word pair whose members were in proximity to the same words in Roget's hierarchy is more closely related than those word pairs whose members do not have nearby words in common. This metric takes the words that A and B have in common and divide this number by the total number of unique words in A and B together.

Table 2 - Word Counting for "midday-noon", semicolon level

Word	Words in Smallest Common Level (w(a), w(b))	W(ab)	Words in Common (W(a)+W(b)-W(ab)	W(common)/ W(ab)
Midday	14	16	14+16-16 = 14	14/16 = .875
Noon	16			

The level being tested here is the semicolon level, or level 2 of the pyramid. "Midday" has 14 words in level 2, and "Noon" has 16. W(ab) is the number of unique words between both words' level 2's. It is the union of the two sets, with duplicates removed. The value for this word pair equals their 14 words in common divided by their 16 unique words in the level in question. Each word pair is figured in this fashion. Those word pairs that had no words in common in the level in question finished with a rating of zero.

The only factors affecting the value of this metric are the number of words in common between the two words' pyramids and the total number of words in each pyramid, not how close the two amounts of words are together. This is a definite improvement over the last metric. This metric had the following correlations:

Table 3 - Correlations for Word Counting

Level	Correlation
Semicolon	.5752
Paragraph	.6558
Category	.7669

A problem with this metric was that if word A had many different meanings, word B could be a synonym of one of the senses but not the others, and no matter how close the two words were in meaning, the score would be low. This problem was partially solved by comparing the words in common between the two to the number of words in the pyramid of B, where B is the word with fewer words in its pyramid. This does not solve the problem if both A and B have many meaning and they only coincide on one.

Table 4 - Word Counting 2 for "midday-noon", semicolon level

Word	Words in Smallest Common Level (w(a), w(b))	W(ab)	Words in Common (W(a)+W(b)-W(ab)	W(common)/W(b)
Midday	14	16	14+16-16 = 14	14/14 = 1.000
Noon	16			

This increased the correlation in the category level to .8219.

Item Counting

The Item Counting metric is identical to the Word Counting metric, except instead of using the number of words in the pyramid for the values of W(a) and W(b), it uses the number of places that the word appears in the thesaurus. This reduces the problem of words whose meanings happen to have a lot of related words always getting bad scores because W(ab) was too large. Also, in Roget's, there are many groups of the paragraph level which are lists of things related to a concept but which aren't synonyms to each other. (E.g. "car 279.19.3" is a member of a moderately large list of aerostat parts.) In the Item Counting metric, each placement in the thesaurus counts one, without extra weight being given to those placements in denser parts of the thesaurus.

Table 5 - Item Counting for "midday-noon", category level

Correlation for Item Count

Word	Placements	I(ab)	Words in Common (I(a)+I(b)-I(ab)	I(common)/I(ab)	Places in common compared to:	Correlation
Midday	1	2	1+2-2=1	1 / 2 = .5000	Total unique places	.8165
Noon	2				Places of less common member	.8226

This performed better than the word counting metric, and performed respectfully compared to metrics done by other researchers in the field. As with the Word Counting metric, it performed better when I(common)/I(b) was used instead of I(common)/I(ab), where B is the word with fewer placements.

The Reciprocal Metric

All of the metrics previously discussed compared words that were related, and compared their relatedness through how many other words or placements each word had. However, if two words were essentially unrelated, there was no way to measure how unrelated they were. Unless two words shared the same category in at least one placement, the resulting score would be zero. Thirteen of the standard twenty-eight word pairs are not located in the same category with each other. This is a large degree of ambiguousness in one end of the scale. Using a meterstick to measure distances works fine when the distances are quite large, but a meterstick is useless in measuring the diameter of microbes, and this is what these metrics were doing with the words that were essentially unrelated. The Reciprocal metric uses the pyramid view of Roget's hierarchy and the idea that two words in a populous group are less related than two in a less populous group at the same level to determine the relatedness of any word pair, whether they were in the same category or not.

In a parallel electrical circuit, each extra path that is provided reduces the total resistance of the circuit. An additional path that has a high resistance allows little current to flow through it, but some does flow through, and, more total current flowing through means less resistance (I=V/R, increase the current (I), the resistance (R) is lowered). The total resistance of a parallel circuit is always less than the resistance of the least resistant path. This axiom of electrical engineering can be applied to semantic relatedness. If a word has one select group in a common with another, but none of the other senses of either word have any group in common, this word pair would be less related than a pair which has either two of those select groups or one select group and one less select group in common. However, the less select groups in common mean less relatedness, and should contribute less to the total relatedness. The formula for resistance in a parallel circuit (with n alternate paths) is:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_n}$$

The formula used for the reciprocal metric is identical, except the number of words in each group that a word pair had in common was used in the denominator instead of resistances.

Each possible combination was used to discover what groups a word pair had in common. For example, "car" is found in three places in Roget's, while "automobile" is found in four. This makes twelve possible combinations:

Table 6 - Smallest Common Groups for "Car - Automobile"

	Automobile 271.9.1	Automobile 272.13.1	Automobile 347.18.3	Automobile 348.26.4
Car 279.19.3	Class 2 Group IV Letter B Level 5 6197 words	Class 2 Group IV Letter B Level 5 6197 words	No common group Level 8 199274 words	No common group Level 8 199274 words
Car 271.13.1	Category 271 Level 4 586 words	Class 2 Group IV Letter B Level 5 6197 words	No common group Level 8 199274 words	No common group Level 8 199274 words
Car 271.9.1	Semicolon group Level 2 10 words	Class 2 Group IV Letter B Level 5 6197 words	No common group Level 8 199274 words	No common group Level 8 199274 words

For this metric, a separate pyramid is used for each sense of the word, but they are all considered together. In this example, one would look at the pyramid for "car 279.19.3" and look for "automobile 271.9.1". This word can be found on the fifth level of the pyramid, along with 6196 other words.

The value (1/6197) is added to the total for "car-automobile". The same thing happens for "automobile 272.13.1". The level that "automobile 347.18.3" is found on is the bottom level, where all the words in the thesaurus are found, so (1/199274) is added to the total. The same thing is done for "car 271.13.1" and "car 271.9.1". The relatedness for this pair would be calculated:

$$\frac{1}{10} + \frac{1}{586} + \frac{4}{6197} + \frac{6}{199274} \approx .1024 \qquad \frac{1}{.1024} \approx 9.7673$$

This, being done for all twenty-eight word pairs, produced a list of values that ranged from 1.3 to over 49000. It was found that if the natural log of the values were correlated, the result was much better.

The reciprocal metric tends to give better (lower) scores to those word pairs in which each word has more extraneous entries in the thesaurus. A word could have a million entries having nothing to do with its partner, and it could receive a better score than a pair that has one moderately good match. To try and control this problem, the reciprocal metric was figured a second time, using only the number of words in the highest pyramid level used, i.e., "car-automobile" would receive a score of ten, there being ten words in the level 2 semicolon group that "car" and "automobile" share. If a word pair shared more than one group of the same size as its smallest group, they were added in reciprocal fashion (e.g. the pair "bird-cock" shares two categories, one of 2041 and one of 170, their score in this metric was

156.9290.) Again, it was found that the natural logs of the values gotten from these calculations correlated much better than the values themselves.

Table 7 - Correlations for the Reciprocal Metric

	Reciprocal Method – All Matches Used		Reciprocal Method – Smallest Level Used	
	Values	ln (values)	Values	ln (values)
Category Level	.4820	.8267	.5771	.8341
Paragraph Level	.4570	.8374	.5401	.8444
Semicolon Level	.5147	.8426	.5294	.8489

The True/False Metric

Earlier I mentioned that using a meterstick to measure relatedness does not give very good results because of the microbe-sized relations that some of the word pairs have. However, surprisingly enough, measuring relatedness through polarized lenses, metaphorically speaking, gives surprisingly accurate results. Doing a simple true / false test, each word pair was given a value of one if they were in the same category in Roget's (or, in other words, if one word was in the top four levels of the other word's pyramid) and a zero if they weren't in the same category in Roget's. This produced a bizarre-looking list of results that consisted of fifteen ones followed by thirteen zeros. However, correlating this with the standard human values given to the word pairs produced a correlation of .9295. This correlation is higher than the upper bound for duplication of the original similarity ratings. To answer the question of why such a simple and unsophisticated metric should work so well without even bothering to differentiate beyond labels of "related" and "unrelated" requires a look into the word pairs and the human rankings themselves. It requires more than a simple correlation of one whole list of results from a particular metric to the whole list of human results.

Nature of the word pairs

Looking at the human rankings for the word pairs, it becomes quickly obvious that the word pairs are divided into two even groups. In the original Miller and Charles ranking of the twenty-eight standard word pairs, (1991) the top ranking is 3.92, and it steadily decreases until there is a huge jump in the middle between "brother/monk" to "crane/implement". This jump of 1.14 is by far the largest jump between two adjacent word pairs. The fact that this jump exists makes it such that a metric that can perceive this jump as starkly as possible gets a high correlation, while another metric which perceives more nuance does not do so well. If a metric was really perceiving the nuance of which words were

related and how much, then they would correlate well with the top or bottom half alone. Otherwise, it is safe to assume that the metric's success is at least in part due to the nature of the word pairs, and not entirely due to its being able to accurately measure the relatedness of word pairs.

Table 8 - Top Half / Bottom Half Correlations (Based on values found in Mc Hale 98)

Method	Correlation	Correlation – Top 14	Correlation – Bottom 14
Human Retrial	.9583	.8058	.6516
WordNet IC	.7911	.5206	.3491
WordNet Edges	.6645	.6400	.3171
Roget's IC	.7900	.3861	.3359
Roget's Edges	.8862	.4587	.3259
Roget's Intervening Words	.5734	.4005	.4007
Item Counting 2	.8226	.2749	.5042
Word Counting 2	.8219	-.0110[3]	.5065
True/False	.9295	.0000[4]	.5042
Reciprocal	.8426	.3924	.2480
Reciprocal – Best Match	.8489	.4109	.2826

[3] This correlation is negative because it actually comes out backwards, i.e. the metric should give higher scores to better matches but in this case it didn't.

[4] The limit of the correlation formula as one of the lists approaches uniformity (e.g. [1 1 1 1 1]) is zero. The formula actually works out to 0/0 and is undefined.

No metrics currently hold up well to this extra scrutiny. Counting edges in WordNet is most consistent between the top half and overall correlation. As for the bottom half, the metrics which tend to ignore the bottom half entirely did the best with it, because the first member of the bottom half was given a value by the True / False, Item Count, and Word Count metrics, while most of the rest of the values were not. In general, though, the metrics did pretty badly when half their values were correlated with half the word pairs. It then follows that most of the metrics' success derives from their perceiving the top half's being related and the bottom half's not being related and not so much from perceiving the degree of relatedness. However, that is too broad a statement to make based on the results from one group of word pairs. What is needed is another group of new word pairs, so it can be determined which metrics give what kind of accuracy in general, instead of which metrics work for these particular twenty-eight word pairs. It seems bizarre to suggest that a simple one / zero pattern created with Roget's Thesaurus is the best way to tell how related word pairs are, but according to these particular word pairs, that is what research seems to suggest. Until other groups of word pairs are tested, it will be impossible to know whether the results from these twenty-eight are an anomaly or not.

Table 10 - Results of Metrics

Word Pair	Human	Item Counting[5]	Word Counting	True / False	Reciprocal[6]	Reciprocal (Best Match)
car-automobile	3.92	0.3333	0.4953	1	2.2790	2.3026
gem-jewel	3.84	0.6000	0.5517	1	0.3075	0.3567
journey-voyage	3.84	1.0000	1.0000	1	2.5877	2.6317
boy-lad	3.76	0.5000	0.5685	1	2.0792	2.0794
coast-shore	3.70	0.5000	0.2070	1	1.9439	1.9459
asylum-madhouse	3.61	1.0000	1.0000	1	2.1971	2.1972
magician-wizard	3.50	1.0000	1.0000	1	5.1976	5.1985
midday-noon	3.42	1.0000	1.0000	1	1.0986	1.1676
furnace-stove	3.11	1.0000	1.0000	1	1.1477	1.3863
food-fruit	3.08	0.5000	0.7736	1	7.2269	7.2269
bird-cock	3.05	0.3333	0.7035	1	4.8968	5.0558
bird-crane	2.97	0.1667	0.6494	1	6.9525	7.6212
tool-implement	2.95	0.6667	0.8090	1	0.2838	0.2877
brother-monk	2.82	0.3333	0.2530	1	3.2874	3.3322
crane-implement	1.68	0.3333	0.7054	1	5.8111	5.9067
lad-brother	1.66	0.0000	0.0000	0	8.9704	9.4767
journey-car	1.16	0.0000	0.0000	0	6.9401	6.9401
monk-oracle	1.10	0.0000	0.0023	0	9.7176	9.7176
food-rooster	0.89	0.0000	0.0096	0	10.8161	10.8161
coast-hill	0.87	0.0000	0.0000	0	8.5729	9.0372
forest-graveyard	0.84	0.0000	0.0000	0	7.7871	7.7871
monk-slave	0.55	0.0000	0.0000	0	9.2067	9.2067
coast-forest	0.42	0.0000	0.0000	0	8.1377	8.4355
lad-wizard	0.42	0.0000	0.0000	0	10.8161	10.8161
chord-smile	0.13	0.0000	0.0000	0	7.6645	8.3860
glass-magician	0.11	0.0000	0.0000	0	9.7175	9.4944
noon-string	0.08	0.0000	0.0000	0	6.5441	7.2416
rooster-voyage	0.08	0.0000	0.0006	0	10.1230	10.1230

[5] These, and the Word Counting figures, are based on the (W(a)+W(b)-W(ab))/W(b) formula.
[6] Shown is ln (values)

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WEB MANAGEMENT AT A GOVERNMENT SITE

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Final Report for:
High School Apprenticeship Program
AFRL/Rome Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

And

Rome Laboratory

August 1998

Abstract: The Basics Of My Job Were:

- to update the current Rome Labs web structure to fit a template an thus end up with a universal "look and feel"
- to create any new pages that are requested
- attend web group meetings and offer suggestions

Methodology:

The majority of my summer work time was spent converting web pages to a common template to standardize the navigation method in the different programs represented on the site. The template also offered time and date stamps, webmaster and POC email, PA numbers, and a choice of a white or a pattern background.

These additions were accomplished by using two methods. The first method was a basic Unix shell script to remove the title and body of a page and place them in a predefined template. Barring the successful completion of this script, the pages would have to be updated by hand. The script failed when the original page was lacking any of the previous standards. A page created by a program such as Microsoft Frontpage™ or Microsoft Word 97™ would fail because of the often-inefficient ways that the pages are generated. Seventy-five percent of updates were thus completed by hand.

Either method chosen was implemented on a Macintosh II series computer used as a telnet client to a Sun Ultra 2 running SunOS 5.6. After being updated each page was checked with multiple Netscape Navigator™ versions on MacOS, WindowsNT, and Unix systems.

Appendix A

An example of a template:

```
<HTML>
<HEAD>
<!--IF Division and Branch Template revision C-->
<!------Replace the web page title within the TITLE tags below----->
<!----------********************************************---------->
<TITLE></TITLE>
<!----------********************************************---------->
<!---Insert the one-line description for the web page document----->
<!----------------within the CONTENT quotes below---------------->
<!----------********************************************---------->
<META NAME="description" CONTENT="">
<!----------********************************************---------->
<!------ Once the page has received Public Affairs approval, ------>
<!--- insert the PA Approval number in the CONTENT quotes below --->
<!----------********************************************---------->
<META NAME="PA Approval" CONTENT="">
<!----------********************************************---------->
<!------Insert the keywords for the web page document within the--->
<!--------------------CONTENT quotes below-------------------->
<!----------********************************************---------->
<META NAME="keywords" CONTENT="">
<!----------********************************************---------->
<!-- Page expiration interval -->
<!----------********************************************---------->
<META NAME="expiration-interval" CONTENT="6 months">
<!----------********************************************---------->
</HEAD>
<BODY BACKGROUND="/Images/background.jpg" TEXT="#000000" LINK="#6633ff"
vLINK="#6633ff">
```

```
<!-- Overall page width is 600 pixels -->
<!-- Width of left bar backgound is 167 pixels including shadow -->
<!-- Define table that contains the left bar -->
<TABLE WIDTH=167 BORDER=0 CELLSPACING=1 align=left>
<!--Left image map-->
<TR vALIGN=top>
<TD>
<A HREF="http://www.afrl.af.mil"><IMG SRC="/Images/AFRL1.gif" HEIGHT=120 width=127
BORDER=0 ALT="AFRL Shield, linked to main ARFL web site">
</A><BR><BR>
<A HREF="/Images/left_bar.map"><IMG BORDER=0 HEIGHT=330 WIDTH=130
SRC="/Images/left_bar.gif" ALT="To view this area, turn on your AUTO LOAD IMAGES option"
ISMAP></A>
</TD>
</TR>
<!--End left image map-->
</TABLE>
<!-- Right side of page defined here -->
<!-- Table size is 600 - 167 = 433 pixels wide -->
<TABLE WIDTH=433 BORDER=0>
<!-- Top image map -->
<!-- First row has navigational button bar -->
<TR vALIGN=top>
<TD COLSPAN=2 ALIGN=center>
<A HREF="/Images/top_bar.map"><IMG BORDER=0 ALIGN=center SRC="/Images/top_bar.gif"
WIDTH=430 HEIGHT=21 ALT="To view this area, turn on your AUTO LOAD IMAGES option"
ISMAP></A>
</TD>
</TR>
<!--End top image map-->

<!-- second row has 'Quick Access' option -->
<TR>
<TD ALIGN=left vALIGN=top>
<IMG ALIGN=right SRC="/Images/quick_access.gif" BORDER=0 WIDTH=140 HEIGHT=22
ALT="Quick Access...">
</TD>
<!--QuickAccess menu-->
<TD ALIGN=left>
<FORM METHOD=GET ACTION="/cgi-bin/menu.cgi">
 <SELECT NAME="URL">
 <OPTION SELECTED VALUE="1">Web Site Directory
 <OPTION  VALUE="2">Locator (personnel,maps...)
 <OPTION  VALUE="3">Technology Index
 <OPTION VALUE="4">Technical Library
  </SELECT>
<INPUT TYPE="submit" VALUE="Go">
</FORM>
</TD>
</TR>
<!--End Quick Access menu area-->
<!-- Third "row" contains page content -->
<TR>
<TD COLSPAN=2>
```

```
<!-- The content of your page goes here. It is the "playing field". -->
<!-------- This is where you are allowed to be creative. ---------->
<!---------**********************************************----------->

<!---------**********************************************----------->
<!----------------- End of the playing field.------------------->
</TD>
</TR>
<!-- Final row contains update info and POC email addresses -->
<TR>
<TD COLSPAN=2>
<P><FONT SIZE=2>
<I>Last Updated:
<!---------Enter last date of page modification here---------->
<!---------**********************************************----------->
23 January 1998
<!---------**********************************************----------->
<BR>
<!--Enter the web page creator's email address after the ":" below-->
<!---------**********************************************----------->
<A HREF="mailto:">pagemaster email</A><BR>
<!---------**********************************************----------->
<!----Enter the page's technical point of contact email address --->
<!--------------------after the ":" below---------------------->
<!---------**********************************************----------->
<A HREF="mailto:">Technical POC email</A>
<!---------**********************************************----------->
</I>
</FONT>
</P>
</TD>
</TR>
<!-- End of final row -->
</TABLE>
<!-- end of right side table -->
</BODY>
</HTML>
```